



EasiPLUS
MI 3000
Instruction manual
Version 1.1, HW 3; Code No. 20 751 466

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1 Preface

Congratulations on your purchase of the EasiPLUS instrument and its accessories from METREL. The instrument was designed on a basis of rich experience, acquired through many years of dealing with electric installation test equipment.

The EasiPLUS instrument is professional, multifunctional, hand-held test instrument intended to perform all the measurements required in order for a total inspection of electrical installations in buildings. The following measurements and tests can be performed:

- ❑ Voltage and frequency,
- ❑ Continuity tests,
- ❑ Insulation resistance tests,
- ❑ RCD testing,
- ❑ Fault loop / RCD trip-lock impedance measurements,
- ❑ Line impedance,
- ❑ Phase sequence,

The large graphic matrix display with backlight offers easy to read results, indications, measurement parameters and messages. The operation of the instrument is designed to be as simple and clear as possible and no special training (except for the reading this instruction manual) is required in order to begin using the instrument.

To become more familiar with how to perform measurements in general and in typical applications, we recommend reading Metrel handbook *Measurements on electric installations in theory and practice*.

The instrument is equipped with all accessories required in order to perform testing comfortably. The soft carrying bag, included with the meter, protect the instrument and keep all accessories together making it simple and easy to move between locations.

2 Safety and operational considerations

2.1 Warnings and notes

In order to maintain the highest level of operator safety while carrying out various tests and measurements, Metrel recommends keeping your EasiPLUS instruments in good condition and undamaged.. When using the instrument, consider the following general warnings:

- ❑ The  symbol on the instrument means »Read the Instruction manual with special care for safe operation«. The symbol requires an action!
- ❑ If the test equipment is used in a manner not specified in this user manual, the protection provided by the equipment could be impaired!
- ❑ Read this user manual carefully, otherwise the use of the instrument may be dangerous for the operator, the instrument or for the equipment under test!
- ❑ Do not use the instrument or any of the accessories if any damage is noticed!
- ❑ If a fuse blows in the instrument, follow the instructions in this manual in order to replace it!
- ❑ Consider all generally known precautions in order to avoid risk of electric shock while dealing with hazardous voltages!
- ❑ Do not use the instrument in supply systems with voltages higher than 550 V!
- ❑ Service intervention or adjustment is only allowed to be carried out by a competent authorized personnel!
- ❑ Use only standard or optional test accessories supplied by your distributor!
- ❑ Consider that older accessories and some of the new optional test accessories compatible with this instrument only meet CAT III / 300 V overvoltage safety rating! This means that maximal allowed voltage between test terminals and ground is 300 V!
- ❑ The instrument comes supplied with rechargeable Ni-Cd or Ni-MH battery cells. The cells should only be replaced with the same type as defined on the battery compartment label or as described in this manual. Do not use standard alkaline battery cells while the power supply adapter is connected, otherwise they may explode!
- ❑ Hazardous voltages exist inside the instrument. Disconnect all test leads, remove the power supply cable and switch off the instrument before removing battery compartment cover.
- ❑ All normal safety precautions must be taken in order to avoid risk of electric shock while working on electrical installations!

Warnings related to measurement functions

Insulation resistance

- ❑ Insulation resistance measurement should only be performed on de-energized objects!
- ❑ When measuring the insulation resistance between installation conductors, all loads must be disconnected and all switches closed!
- ❑ Do not touch the test object during the measurement or before it is fully discharged! Risk of electric shock!
- ❑ When an insulation resistance measurement has been performed on a capacitive object, automatic discharge may not be done immediately! The warning message  and the actual voltage is displayed during discharge until voltage drops below 10 V.
- ❑ Do not connect test terminals to external voltage higher than 550 V (AC or DC) in order not to damage the test instrument!

Continuity functions

- ❑ Continuity measurements should only be performed on de-energized objects!
- ❑ Parallel impedances or transient currents may influence test results.

Testing PE terminal

- ❑ If phase voltage is detected on the tested PE terminal, stop all measurements immediately and ensure the cause of the fault is eliminated before proceeding with any activity!

Notes related to measurement functions

General

- ❑ The  indicator means that the selected measurement cannot be performed because of irregular conditions on input terminals.
- ❑ Insulation resistance, continuity functions and earth resistance measurements can only be performed on de-energized objects.
- ❑ PASS / FAIL indication is enabled when limit is set. Apply appropriate limit value for evaluation of measurement results.
- ❑ In the case that only two of the three wires are connected to the electrical installation under test, only voltage indication between these two wires is valid.

Insulation resistance

- ❑ If voltages of higher than 10 V (AC or DC) are detected between test terminals, the insulation resistance measurement will not be performed.

Continuity functions

- ❑ If voltages of higher than 10 V (AC or DC) are detected between test terminals, the continuity resistance test will not be performed.
- ❑ Before performing a continuity measurement, where necessary, compensate test lead resistance.

RCD functions

- ❑ Parameters set in one function are also kept for other RCD functions!
- ❑ The measurement of contact voltage does not normally trip an RCD. However, the trip limit of the RCD may be exceeded as a result of leakage current flowing to the PE protective conductor or a capacitive connection between L and PE conductors.
- ❑ The RCD trip-lock sub-function (function selector switch in **LOOP** position) takes longer to complete but offers much better accuracy of fault loop resistance (in comparison to the R_L sub-result in **Contact voltage** function).
- ❑ RCD trip-out time and RCD trip-out current measurements will only be performed if the contact voltage in the pre-test at nominal differential current is lower than the set contact voltage limit!
- ❑ The autotest sequence (RCD AUTO function) stops when trip-out time is out of allowable time period.

Fault loop / RCD trip-lock impedance

- ❑ The low limit prospective short-circuit current value depends on fuse type, fuse current rating, fuse trip-out time and impedance scaling factor.
- ❑ The specified accuracy of tested parameters is valid only if the mains voltage is stable during the measurement.
- ❑ Fault loop impedance measurements will trip an RCD.
- ❑ The measurement of fault loop impedance using trip-lock function does not normally trip an RCD. However, the trip limit may be exceeded as a result of leakage current flowing to the PE protective conductor or a capacitive connection between L and PE conductors.

Line impedance

- ❑ The low limit prospective short-circuit current value depends on fuse type, fuse current rating, fuse trip-out time and impedance scaling factor.
- ❑ The specified accuracy of tested parameters is valid only if the mains voltage is stable during the measurement.

Testing the PE terminal

- ❑ The PE terminal can only be tested in the RCD, LOOP and LINE functions!
- ❑ For correct testing of PE terminal, the TEST key has to be touched for a few seconds.
- ❑ Make sure to stand on non-isolated floor while carrying out the test, otherwise the test result may be wrong!

2.2 Batteries

- ❑  When connected to an installation, the instruments battery compartment can contain hazardous voltage inside! When replacing battery cells or before opening the battery/fuse compartment cover, disconnect any measuring accessory connected to the instrument and turn off the instrument,
- ❑ Ensure that the battery cells are inserted correctly otherwise the instrument will not operate and the batteries could be discharged.
- ❑ If the instrument is not to be used for a long period of time, remove all batteries from the battery compartment.
- ❑ Alkaline or rechargeable Ni-Cd or Ni-MH batteries (size AA) can be used. Metrel recommends only using rechargeable batteries with a capacity of 2100mAh or above.
- ❑ Do not recharge alkaline battery cells!

2.3 Charging

The batteries will begin charging whenever the power supply adapter is connected to the instrument. The built-in protection circuits control the charging procedure and assure maximum battery lifetime. The power supply socket polarity is shown in figure 2.1.



Figure 2.1: Power supply socket polarity

Note:

- ❑ Use only power supply adapter delivered from the manufacturer or distributor of the test equipment to avoid possible fire or electric shock!

2.4 Precautions on charging of new battery cells or cells unused for a longer period

Unpredictable chemical processes can occur during the charging of new battery cells or cells that have been left unused for long periods of time (more than 3 months). Ni-MH and Ni-Cd cells can be subject to these chemical effects (sometimes called the memory effect). As a result the instrument operation time can be significantly reduced during the initial charging/discharging cycles of the batteries.

In this situation, Metrel recommend the following procedure to improve the battery lifetime:

- ❑ Completely charge the batteries for at least 14h via the instrument built-in charger.
- ❑ Completely discharge the batteries (this can be performed by using the instrument normally until the instrument is fully discharged).
- ❑ Repeat the charge/discharge cycle at least 2-4 times in order to restore the batteries to their normal capacity..

When using an external intelligent battery charger, one complete discharging/charging cycle can be performed automatically. After performing this procedure, a normal battery capacity should be fully restored and the operating time of the instrument will approximately meet the data set out in the in the technical specification.

Notes:

- ❑ The charger in the instrument is a pack cell charger. This means that the cells are connected in series during the charging so all of them must be in similar state (similarly charged, same type and age).
- ❑ If even one deteriorated battery cell (or just one of a different type e.g. capacity, chemical design) can cause disrupted charging of the entire battery pack which could lead to overheating of the battery pack and a significant decrease in the operating time.
- ❑ If no improvement is achieved after performing several charging/discharging cycles, the state of each individual battery cells should be determined (by comparing battery voltages, checking them in a cell charger, etc). It is very likely that one or more of the battery cells could have deteriorated.
- ❑ The effects described above should not be mixed with the normal battery capacity decrease over time. All charging batteries lose some of their capacity when repeatedly charged/discharged. The actual decrease in capacity compared to the number of charging cycles depends on the battery type. This information is normally provided in the technical specification from battery manufacturer.

2.5 Standards applied

The EasiPLUSEASI instrument is manufactured and tested in accordance with the following regulations:

Electromagnetic compatibility (EMC)

BS EN 61326	Electrical equipment for measurement, control and laboratory use – EMC requirements Class B (Hand-held equipment used in controlled EM environments)
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Safety (LVD)

BS EN 61010-1	Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements
BS EN 61010-031	Safety requirements for hand-held probe assemblies for electrical measurement and test
BS EN 61010-2-032	Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 2-032: Particular requirements for hand-held and hand-manipulated current sensors for electrical test and measurement

Functionality

BS EN 61557	Electrical safety in low voltage distribution systems up to 1000 V _{AC} and 1500 V _{AC} – Equipment for testing, measuring or monitoring of protective measures Part 1 General requirements Part 2 Insulation resistance Part 3 Loop resistance Part 4 Resistance of earth connection and equipotential bonding Part 6 Residual current devices (RCDs) in TT and TN systems Part 7 Phase sequence Part 10..... Combined measuring equipment
DIN 5032	Photometry Part 7 Classification of illuminance meters and luminance meters

Other reference standards for testing RCDs

BS EN 61008	Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses
BS EN 61009	Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses
EN 60364-4-41	Electrical installations of buildings Part 4-41 Protection for safety – protection against electric shock
BS 7671	IEE Wiring Regulations (17 th edition)

Note about EN and IEC standards:

- Text of this manual contains references to European and British standards. All standards of EN 6XXXX (e.g. EN 61010) series are equivalent to IEC standards with the same number (e.g. IEC 61010) and differ only in amended parts required by European harmonization procedure.

3 Instrument description

3.1 Front panel

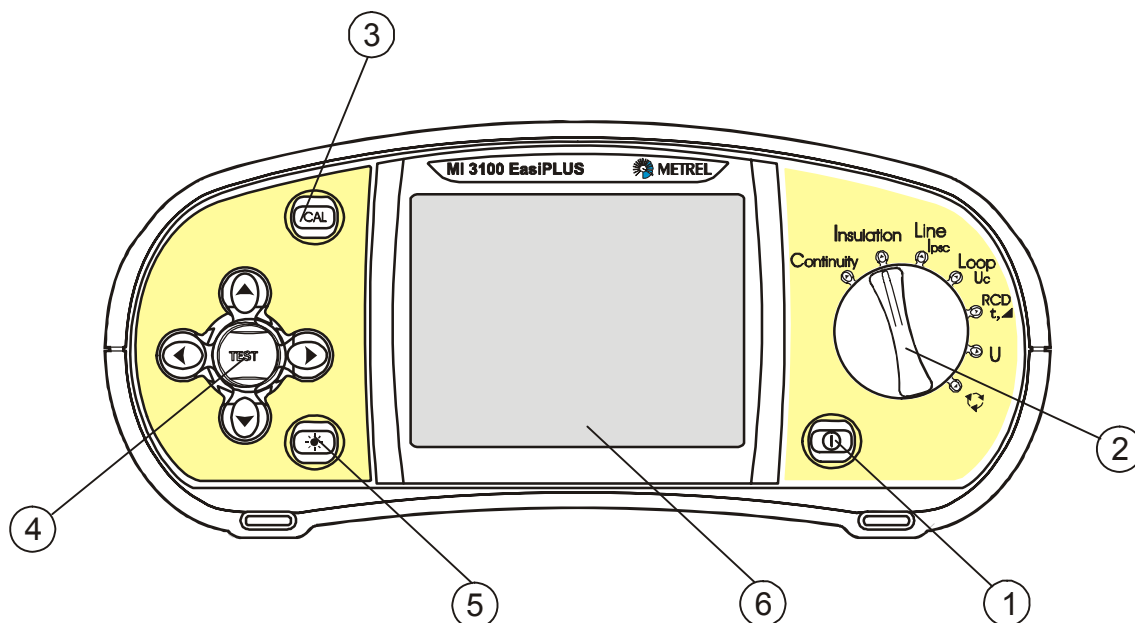


Figure 3.1: Front panel

Legend:

- 1 ON/OFF key, to switch the instrument on and off.
The instrument will automatically switch off 10 minutes after the last key press / function switch rotation.
- 2 Function selector switch.
- 3 CAL key, to compensate for the test lead resistance in low-value resistance measurements.
- 4 Jogger keypad with cursors for navigating screen menus and TEST keys for starting tests.
The TEST key also acts as the PE touching electrode which detects potentially dangerous voltages appearing on the PE conductor.
- 5 BACKLIGHT and CONTRAST key. This is used to turn the backlight on and off and for adjusting the level of the contrast.
The high level backlight is automatically shut off 20 seconds after the last key press / function switch rotation in order to extend service life of the battery.
- 6 128 × 64 dots matrix display with backlight.

3.2 Connector panel

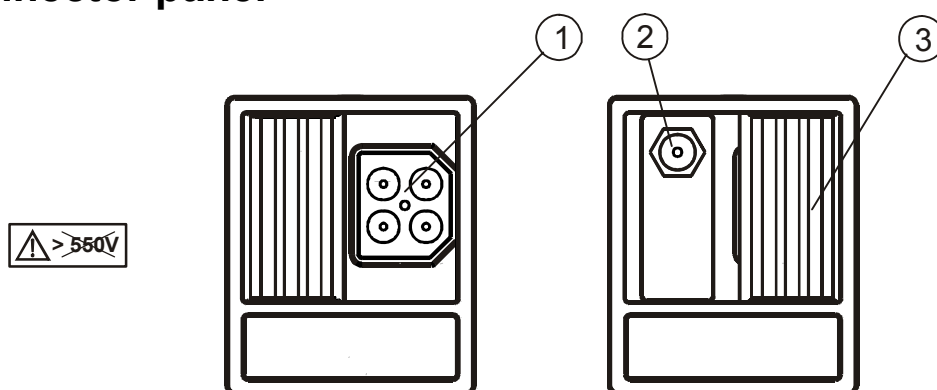


Figure 3.2: Connector panel

Legend:

1 Test connector.

Warning! Maximum allowed voltage between test terminals and ground is 600V! Maximal allowed voltage between test terminals is 550 V!

2 Power supply socket.

3 Protection connector cover.

3.3 Back panel

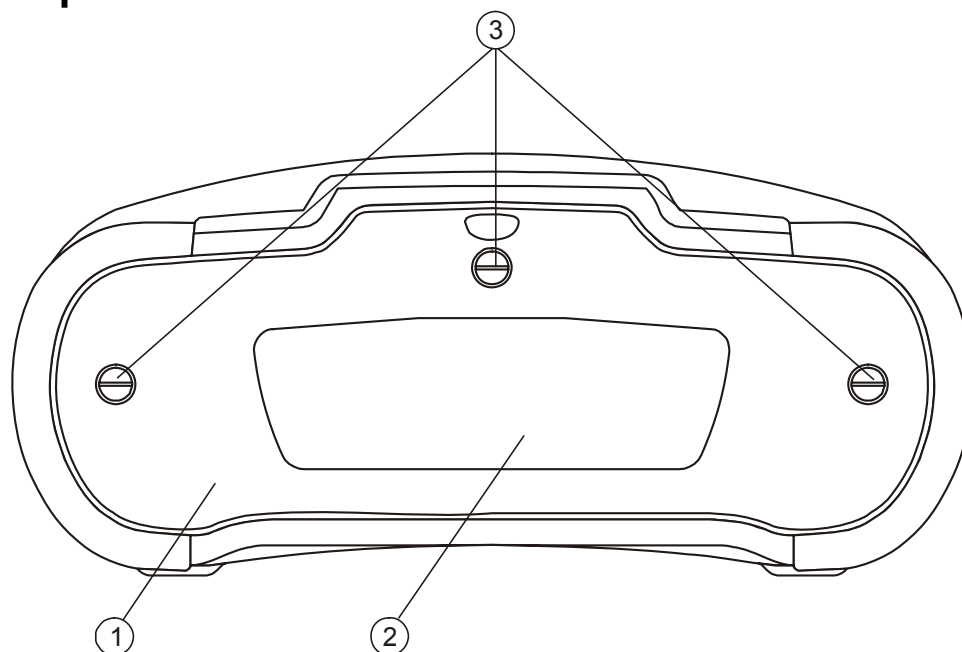


Figure 3.3: Back panel

Legend:

- 1 Battery/fuse compartment cover.
- 2 Information label.
- 3 Fixing screws for battery/fuse compartment cover.

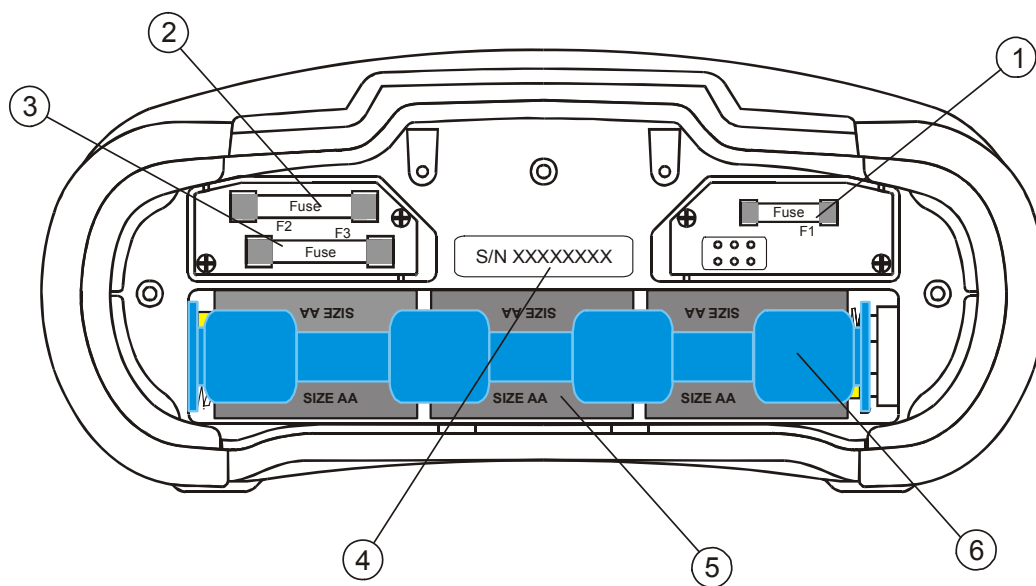


Figure 3.4.: Battery and fuse compartment

Legend:

- 1 Fuse F1.
- 2 Fuse F2.
- 3 Fuse F3.
- 4 Serial number label.
- 5 Battery cells (size AA).
- 6 Battery holder.

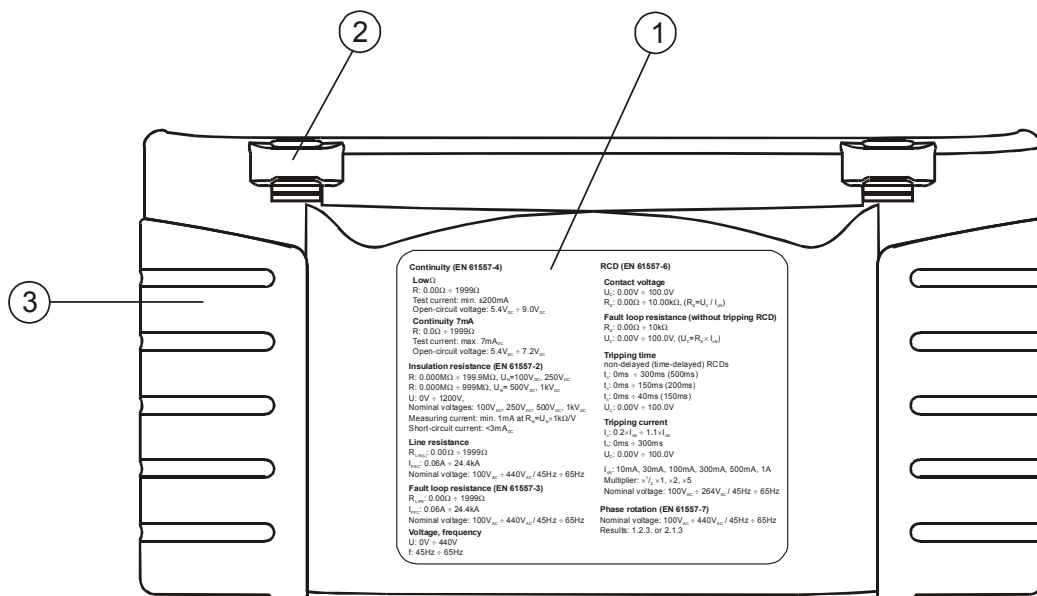
3.4 Bottom view

Figure 3.5: Bottom view

Legend:

- 1 Information label.
- 2 Neck strap openings.
- 3 Handling side covers.

3.5 Carrying the instrument

The neck strap supplied in standard set allows the instrument to be carried in a variety of different ways.. The operator can choose the most appropriate method based on the tasks they are performing. See the following examples:



The instrument can be hung around operator's neck allowing the instrument to move freely. This allows equipment to be moved quickly between test locations.



The instrument can be used from inside the soft carrying case – test cables can be connected to the instrument through the front flap of the carry case.

4 Instrument operation

4.1 Meaning of symbols and messages on the instrument display

The instrument display is divided into four sections:

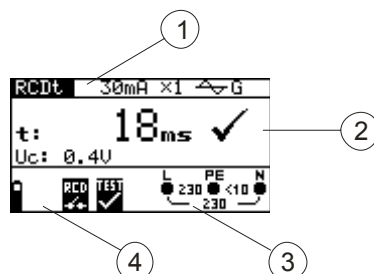
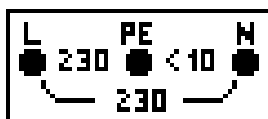


Figure 4.1: Display outlook

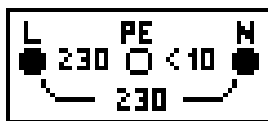
Legend:

- 1 Function and parameter line.
In the top line of the display, the measuring function/sub-function and parameters are displayed.
- 2 Result field.
In this field the main result and sub-results together with the PASS/FAIL/ABORT status are displayed.
- 3 Online voltage and output monitor.
- 4 Message field.

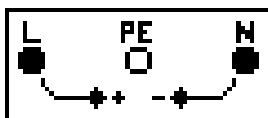
4.1.1 The online voltage and output terminal monitor



Online voltages are displayed together with test terminal indication. All three test terminals are used for selected measurement.



Online voltages are displayed together with test terminal indication. L and N test terminals are used for selected measurement.



Polarity of test voltage applied to the output terminals, L and N.



Unknown supply system.



L – N polarity changed.



Frequency out of range.

4.1.2 Message field – battery status



Battery power indication.

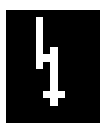


Low battery indication. Battery pack is too weak to guarantee correct result. Replace the batteries.

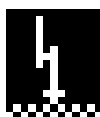


Recharging is running (if power supply adapter is connected).

4.1.3 Message field – measurement warnings/messages



Warning! High voltage is applied to the test terminals.



Warning! Phase voltage on the PE terminal! Stop all the measurements immediately and eliminate the fault before proceeding with any activity!



Measurement is running. Consider any displayed warnings!



Measurement can be performed after pressing the TEST key. Consider any displayed warning after starting the measurement!



Measurement prohibited. Consider any displayed warnings and check online voltage/terminal monitor!



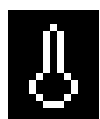
Test leads resistance in low-value resistance measurement is compensated.



RCD tripped during the measurement. The trip limit may be exceeded as a result of leakage current flowing to the PE protective conductor or capacitive connection between L and PE conductors.



RCD not tripped during the measurement.



Instrument overheated. Temperature of internal components in the instrument reached top limit. Measurement is prohibited until the temperature is lower than that limit.



Battery capacity is too low to guarantee correct result. Replace the batteries.



Fuse F1 (continuity circuit) blown or not inserted.



Single fault condition in IT system.

4.1.4 Result field



Measurement passed.



Measurement failed.



Measurement is aborted. Check the conditions at the input terminal.

4.1.5 Other messages

Hard Reset

Instrument settings and measurement parameters/limits are set to initial (factory) values. For more information refer to chapter 4.4.5. *Recalling original settings*.

CHECK SUM ERROR

Memory contents damaged. Contact your distributor or manufacturer for further information.

4.1.6 Sound warnings

The shortest sound	Pressed key deactivated. Sub-function is not available.
Short sound	Pressed key activated. Measurement has been started after pressing the TEST key. Consider any displayed warnings during measurement.
Long sound	Measurement is prohibited. Consider any displayed warnings and check online voltage/terminal monitor!
Periodic sound	Warning! Phase voltage on the PE terminal! Stop all the measurements immediately and eliminate the fault before proceeding with any activity!

4.1.7 Function and parameter line



Figure 4.2: Function selector switch and belonging parameter line

Legend:

- 1.....Main function name.
- 2.....Function or sub-function name.
- 3.....Measuring parameters and limit values.

4.2 Selecting measurement function/ subfunction

The following measurements can be selected with the function selector switch:

- ☐ Voltage and frequency,
- ☐ Insulation resistance,
- ☐ Low-value resistance,
- ☐ RCD testing,
- ☐ Fault loop impedance,
- ☐ Line impedance,
- ☐ Phase sequence,

The function/sub-function name is highlighted on the display by default.
Sub-function can be selected by using ▲ and ▼ keys in function/parameter line.

4.3 Setting measurement parameters and limits

By using ◀ and ▶ keys select the parameter/limit value you want to edit. By using ▲ and ▼ keys the selected parameter can be set.

Once the measurement parameters are set, the settings are retained until new changes are made or the original settings are recalled.

4.4 Setup menu

In the **Setup** menu, the following actions can be taken:

- ❑ Supply system selection,
- ❑ Prospective short/fault current scaling factor adjustment,
- ❑ Language selection,
- ❑ Support for remote commanders

To enter the **Setup** menu press the BACKLIGHT key and rotate function selector switch in any direction at the same time.

Rotate function selector switch again to leave **Setup** menu or setup sub-menus.

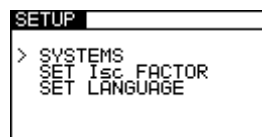


Figure 4.3: Setup menu

4.4.1 Supply system setup

The instrument enables tests and measurements in the following supply systems:

- ❑ TN (TT) system,
- ❑ IT system,
- ❑ Reduced low voltage system (2×55 V),
- ❑ Reduced low voltage system (3×63 V).

Select SYSTEMS in the **Setup** menu by using ▲ and ▼ keys and press the TEST key to enter the **Supply system** setup menu.

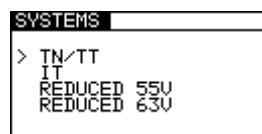


Figure 4.4: Supply systems selecting menu

By using ▲ and ▼ keys select supply system and press the TEST key to accept the setting.

4.4.2 Prospective short/fault current scaling factor adjustment

Select SET I_{SC} FACTOR in **Setup** menu by using ▲ and ▼ keys and press the TEST key to enter the **Prospective short/fault current scaling factor** adjustment menu.

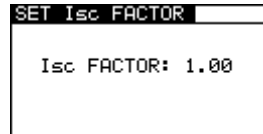


Figure 4.5: Scaling factor adjustment menu

Use ▲ and ▼ keys to adjust the scaling factor. Press the TEST key to accept the new setting.

4.4.3 Language selection

Select SET LANGUAGE in **Setup** menu by using the ▲ and ▼ keys and press the TEST key to enter the **Language** selection menu.

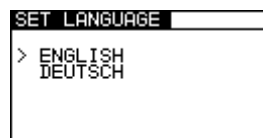


Figure 4.6: Language selecting menu

By using ▲ and ▼ keys select the language you want to use and press The TEST key to accept the new setting.

4.4.4 Plug / Tip commander support

Select COMMANDER in the **Setup** menu by using the ▲ and ▼ keys and press the TEST key to enable / disable the support for remote commanders.

If **disable** is selected, then keys on the Plug / Tip commander are disabled (except backlight key). This implies that the selected test can only be started using the keys on the instrument.

If **enable** is selected, the keys on Plug / Tip commander are activated and tests can be started either from the buttons on the instrument or the buttons on the remote commanders.

Note:

- This option is intended to disable the commander's remote keys. In the case of high EM interfering noise the operation of the commander's key can be irregular.

4.4.5 Recalling original settings

The following parameters and settings can be automatically set back to initial (factory) values:

- ❑ Test parameters and limit values,
- ❑ Contrast,
- ❑ Impedance scaling factor,
- ❑ Supply system,
- ❑ Support for remote commanders

In order to restore the original setting of the instrument, press and hold ➤ key and switch on the instrument (the external charger must not be connected). »Hard reset« message will be displayed at start-up.

Instrument settings, measurement parameters and limits are set to their initial values as follows:

Instrument settings	Default value
Contrast	50 %
Prospective short/fault current scaling factor	1.00
Supply system	TN/TT

Function Sub-function	Parameter / limit value
CONTINUITY	Selected function: R LOWΩ
R LOWΩ	High limit resistance value: 2.0 Ω
Continuity	High limit resistance value: 20.0 Ω
INSULATION	Nominal test voltage: 500 V Low limit resistance value: 1 MΩ
RCD	Selected function: RCD Uc
Contact voltage – RCD Uc	Nominal differential current: I _{ΔN} =30 mA
Trip-out time – RCD t	RCD type and test current starting polarity:  G
Trip-out current – RCD I _{ΔI}	Limit contact voltage: 50 V
Autotest – RCD AUTO	Nominal differential current multiplier: ×1

4.5 Display contrast adjustment

When the low-level backlight is activated, press and hold the BACKLIGHT key until the **Display contrast** adjustment menu is displayed.



Figure 4.7: Contrast adjustment menu

Use the ▲ and ▼ keys to adjust the contrast level and, when satisfied, press the TEST key to accept the new setting.

5 Measurements

5.1 Insulation resistance

The Insulation resistance measurement is performed in order to ensure safety against electric shock. Using this measurement the following items can be determined:

- ❑ Insulation resistance between installation conductors,
- ❑ Insulation resistance of non-conductive rooms (walls and floors),
- ❑ Insulation resistance of ground cables,
- ❑ Resistance of semi-conductive (antistatic) floors.

For additional information concerning insulation resistance measurements refer to Metrel's handbook *Measurements on electric installations in theory and practice*.

How to perform an insulation resistance measurement

Step 1 Select **Insulation** function with the function selector switch. The following menu is displayed:

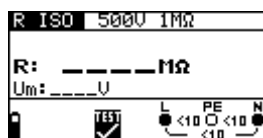


Figure 5.1: Insulation resistance measurement menu

Step 2 Set the following measuring parameter and limit values:

- ❑ Nominal test voltage,
- ❑ Low limit resistance value.

Step 3 Ensure that no voltages are present on the item for testing. Connect the test leads to the EasiPLUS instrument. Connect the test cables to the item under test. (see figure 5.2) to perform insulation resistance measurement.

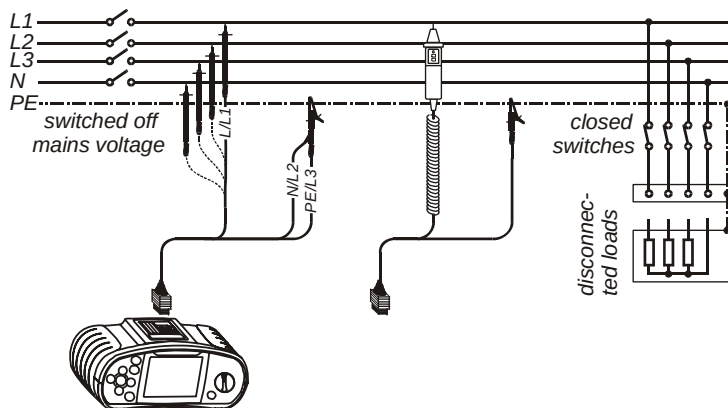


Figure 5.2: Connection of universal test cable and tip commander

- Step 4** Check the displayed warnings and online voltage/terminal monitor before starting the measurement. If OK, press and hold the TEST key until the result has stabilised. Actual measured results are shown on the display during measurement.
- After the TEST key is released the last measured results are displayed, together with the PASS/FAIL indication (if applicable).



Figure 5.3: Example of insulation resistance measurement results

Displayed results:

R.....Insulation resistance,

Um.....Actual voltage applied to item under test

Warnings:

- ❑ Insulation resistance measurement should only be performed on de-energized objects!
- ❑ When measuring the insulation resistance between installation conductors, all loads must be disconnected and all switches closed!
- ❑ Do not touch the test object during the measurement or before it is fully discharged! Risk of electric shock!
- ❑ When an insulation resistance measurement has been performed on a capacitive object, an automatic discharge may not be done immediately! The warning message  and actual voltage is displayed during discharge until the voltage of the item under test drops below 10 V.
- ❑ In order to prevent damaging the test instrument, do not connect test terminals to an external voltage higher than 600 V (AC or DC)

Note:

- ❑ If a voltage higher than 10 V (AC or DC) appears between the test terminals, the insulation resistance measurement will not be performed.

5.2 Continuity

Two continuity sub-functions are available:

- ❑ RLow, 200mA continuity test with automatic polarity reversal
- ❑ Low current (ca 7mA) continuous continuity test, useful when testing inductive systems (e.g. motors, see section 5.2.2 for more details).

5.2.1 R Low Ω test

This function is used to test the resistance between two different points of the installation to ensure that a conductive path exists between them. The test ensures that all protective conductors, earth conductors or bonding conductors are correctly connected, terminated and have the correct resistive value.

The measurement of the Low Ω resistance is performed with a test current of more than 200mA. An automatic pole reversal of the test voltage and the test current is performed during the test. This test checks for any components (e.g. diodes, transistors, SCRs) that may have a rectifying effect on the circuit which could cause problems when a voltage is applied.

This measurement completely complies with EN61557-4 regulations

How to perform a Low Ω resistance measurement

Step 1 Select the **Continuity** function with the function selector switch and the sub-function with the $\blacktriangle/\blacktriangledown$ keys. The following menu will be displayed:

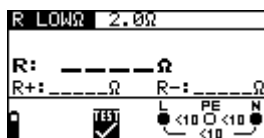


Figure 5.4: Low Ω resistance measurement menu

Step 2 Set the following limit value:

- ❑ High limit resistance value.

Step 3 Connect test cable to the EasiPLUS instrument. Before performing an Low Ω resistance measurement, compensate for the test leads resistance as follows:

1. Short test leads first as shown in figure 5.5.

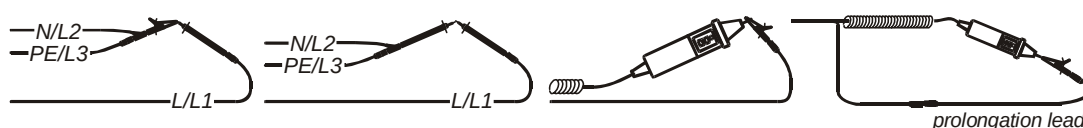


Figure 5.5: Shorted test leads

2. Press the TEST key in order to perform regular measurement. The displayed result should be close to $0.00\ \Omega$. (depending on the length of test leads used).
3. Press the CAL key. After performing test leads compensation the compensated test leads indicator **Co** will be displayed on the top line.
4. In order to remove any test lead resistance compensation, follow the procedure described in step 3 with test leads separated from one another. After removing any test lead compensation, the compensation indicator will disappear from the top line of the display.

Step 4 Ensure that the item for testing is disconnected from any voltage source and it has been fully discharged. Connect the test cables to the item under test. Follow the connection diagrams shown in figures 5.6 and 5.7 to perform a **Low Ω resistance** measurement.

MPEC....Main Potential Equilizing Collector
PCC....Protection Conductor Collector

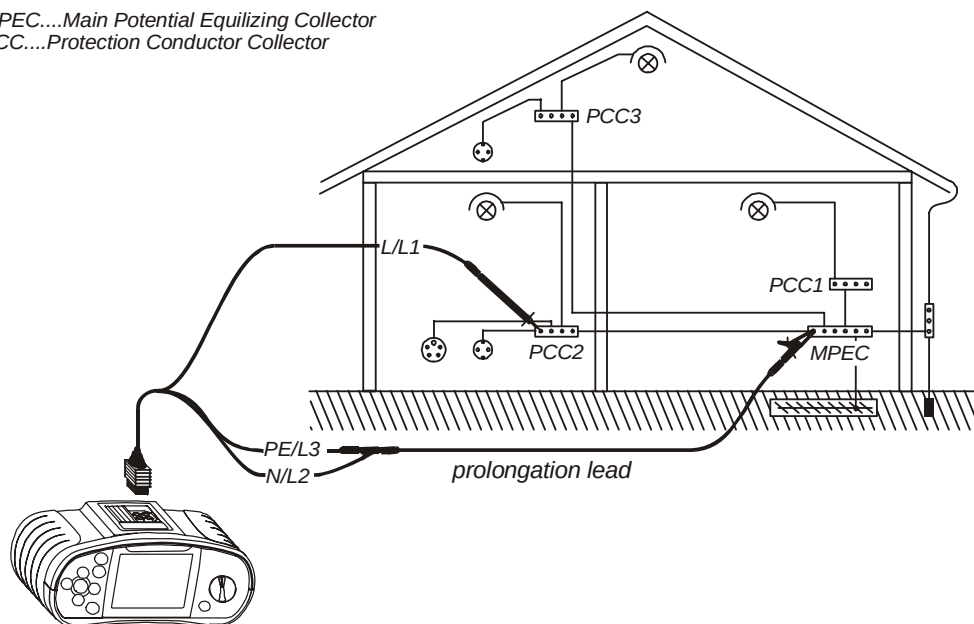


Figure 5.6: Connection of universal test cable and optional probe test lead

MPEC....Main Potential Equilizing Collector
PCC....Protection Conductor Collector

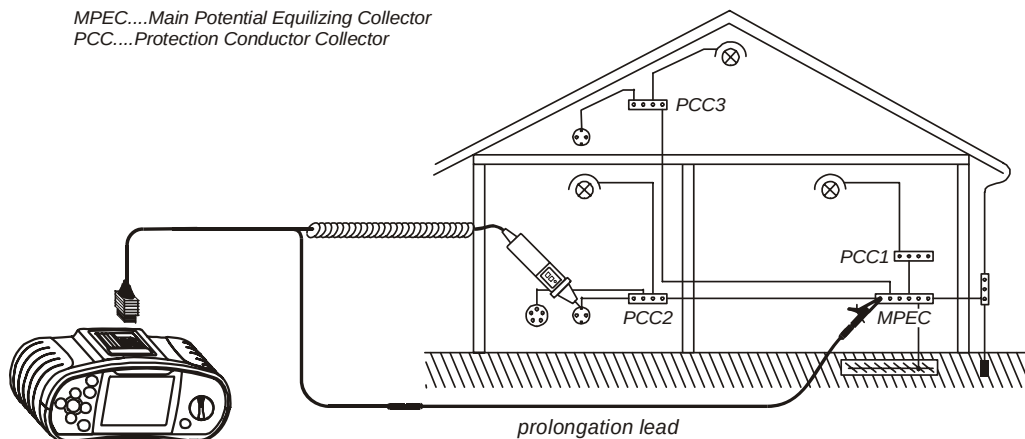


Figure 5.7: Connection of tip commander and optional probe test lead

- Step 5** Check for any warnings and the online voltage/terminal monitor on the display before starting the measurement. If everything is OK, press the TEST key. After performing the measurement, the results appear on the display together with the PASS/FAIL indication (if applicable).

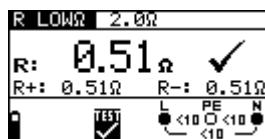


Figure 5.8: Examples of LowΩ resistance measurement results

Displayed results:

- R**.....Main LowΩ resistance result (average of R+ and R- results),
R+.....LowΩ resistance sub-result with positive voltage at L terminal,
R-.....LowΩ resistance sub-result with positive voltage at N terminal.

Warnings:

- ❑ Low-value resistance measurements should only be performed on de-energized objects!
- ❑ Parallel impedances or transient currents may influence test results.

Note:

- ❑ If voltage between test terminals is higher than 10 V the LOWΩ measurement will not be performed.

5.2.2 Low current continuity test

Continuous low-value resistance measurements can be performed without pole reversal of the test voltages and a lower test current (a few mA). In general, the function serves as an ordinary Ω-meter with low-test current. The function can also be used to test inductive components such as motors and coiled cables.

For additional information concerning continuity measurements refer to the Metrel's handbook *Measurements on electric installations in theory and practice*.

How to perform low current continuity measurement

- Step 1** Select **Continuity** function with the function selector switch and use the ▲/▼ keys to select the **Continuity** sub-function. The following menu is displayed:



Figure 5.9: Continuity measurement menu

Step 2 Set the following limit value:

- High limit resistance value.

Step 3 Connect test cable to the instrument and the item under test. Follow the connection diagram shown in figures 5.10 and 5.11 to perform the **Continuity** measurement.

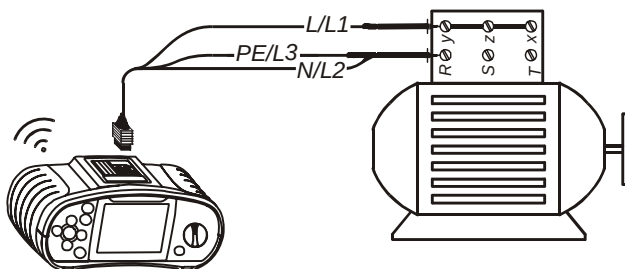


Figure 5.10: Connection of universal test cable

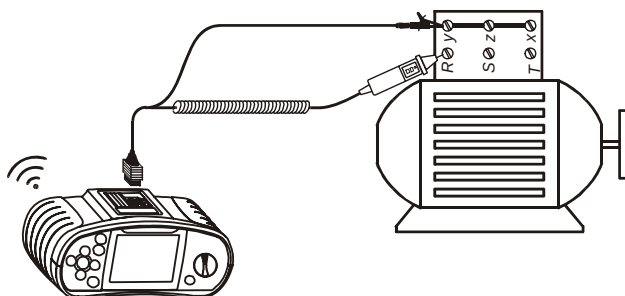


Figure 5.11: Connection of tip commander

Step 4 Check the warnings and online voltage/terminal monitor on the display before starting the measurement. If everything is OK, press the TEST key to start the measurement. The actual measuring result with PASS/FAIL indication (if applicable) will be displayed during the measurement. As this is a continuous test, the function will require stopping. To stop the measurement at any time press the TEST key again. The last measured result will be displayed together with the PASS/FAIL indication (if applicable).

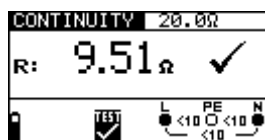


Figure 5.12: Example of Low current continuity measurement result

Displayed result:

R.....Low current continuity resistance result.

Warning:

- Low current continuity measurement should only be performed on de-energized objects!

Notes:

- ❑ If a voltage of higher than 10 V exists between test terminals, the continuity measurement will not be performed.
- ❑ Before performing a continuity measurement, compensate for the test lead resistance (if necessary). The compensation is performed in **Continuity** sub-function **R LowΩ**.

5.3 Testing RCDs

When testing RCDs, the following sub-functions can be performed:

- ❑ Contact voltage measurement,
- ❑ Trip-out time measurement,
- ❑ Trip-out current measurement,
- ❑ RCD autotest.

In general the following parameters and limits can be set when testing RCDs:

- ❑ Limit contact voltage,
- ❑ Nominal differential RCD trip-out current,
- ❑ Multiplier of nominal differential RCD trip-out current,
- ❑ RCD type,
- ❑ Test current starting polarity.

5.3.1 Limit contact voltage

Safety contact voltage is limited to 50 V_{AC} for standard domestic area. In special environments (hospitals, wet places, etc.) contact voltages up to 25 V_{AC} are permitted. Limit contact voltage can be set in contact voltage **Uc** function only!

5.3.2 Nominal differential trip-out current

Nominal differential current is the rated trip-out current of an RCD. The following RCD current ratings can be set: 10 mA, 30 mA, 100 mA, 300 mA, 500 mA and 1000 mA.

5.3.3 Multiplier of nominal residual current

Selected nominal differential current can be multiplied by ½, 1, 2 or 5.

5.3.4 RCD type and test current starting polarity

The EasiPLUS instrument enables testing of general (non-delayed) and selective (time-delayed, marked with the  symbol). The types of RCD the instrument is suitable for testing include:

- ❑ Alternating residual current (AC type, marked with  symbol),
- ❑ Pulsating DC residual current (A type, marked with  symbol).

Test current starting polarity can be started with the positive half-wave at 0° or with the negative half-wave at 180° .

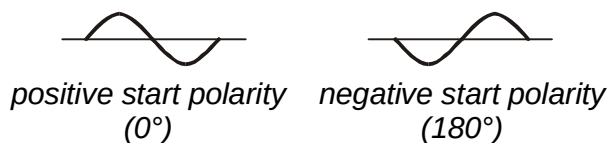


Figure 5.13: Test current started with the positive or negative half-wave

5.3.5 Testing selective (time-delayed) RCDs

Selective RCDs demonstrate delayed response characteristics. Trip-out performance is influenced due to pre-loading during measurement of contact voltage. In order to eliminate the pre-loading a time delay of 30 s is inserted before performing the trip-out test.

5.3.6 Contact voltage

Leakage current flowing to the PE terminal causes a voltage drop across earth resistance, which is called contact voltage (U_c). This voltage is present on all accessible parts connected to the PE terminal and should be lower than the safety limit voltage. The parameter contact voltage is measured without tripping-out the RCD. R_L is a fault loop resistance and is calculated as follows:

$$R_L = \frac{U_c}{I_{\Delta N}}$$

Displayed contact voltage relates to the rated nominal differential current of the RCD and is multiplied by a safety factor. See the table 5.1 for detailed contact voltage calculation.

RCD type	Contact voltage U_c
 	$U_c \propto 1.05 \times I_{\Delta N}$
 	$U_c \propto 1.05 \times 2 \times I_{\Delta N}$
 	$U_c \propto 1.05 \times \sqrt{2} \times I_{\Delta N}$
 	$U_c \propto 1.05 \times 2 \times \sqrt{2} \times I_{\Delta N}$

Table 5.1: Relationship between U_c and $I_{\Delta N}$

For additional general information concerning contact voltage measurement refer to Metrel's handbook *Measurements on electric installations in theory and practice*.

How to perform contact voltage measurement

Step 1 Select **RCD** function with the function selector switch first. Use the Δ/∇ keys to select contact voltage function (U_c). The following menu will be displayed:

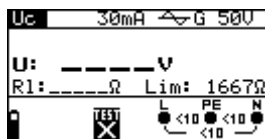


Figure 5.14: Contact voltage measurement menu

Step 2 Set the following measuring parameters and limit values:

- ☐ Nominal residual current,
- ☐ RCD type,
- ☐ Limit contact voltage.

Step 3 Connect the test leads to the instrument and follow the connection diagram shown in figure 5.15 to perform contact voltage measurement.

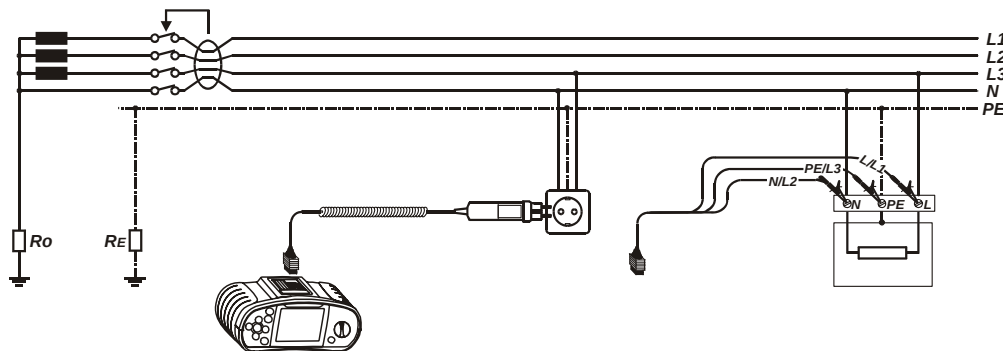


Figure 5.15: Connection of plug test cable or universal test cable

Step 4 Check for any warnings and check the online voltage/terminal monitor on the display before starting the measurement. If everything is ok, press the TEST key. After performing the measurement, the results will be displayed along with a PASS/FAIL indication.



Figure 5.16: Example of contact voltage measurement results

Displayed results:

U Contact voltage.

RI Fault loop resistance.

Lim Limit earth fault loop resistance value according to BS 7671.

Notes:

- ❑ Parameters set in this function are also kept for all other RCD functions!
- ❑ The measurement of contact voltage does not normally trip an RCD. However, the trip limit may be exceeded as a result of leakage currents flowing through the PE protective conductor or a capacitive connection between the L and PE conductor.
- ❑ RCD trip-lock sub-function (function selector switch in **LOOP** position) takes longer to complete but offers much better accuracy of a fault loop resistance result (in comparison with the R_L sub-result in **Contact voltage** function).

5.3.7 Trip-out time

Trip-out time measurement is used to verify the effectiveness of an RCD. This is achieved by a test simulating an appropriate fault condition. Trip-out times vary between standards and are listed below.

Trip-out times according to BS EN 61008 / BS EN 61009:

	$\frac{1}{2} \times I_{\Delta N}^{*)}$	$I_{\Delta N}$	$2 \times I_{\Delta N}$	$5 \times I_{\Delta N}$
General (non-delayed) RCDs	$t_{\Delta} > 300 \text{ ms}$	$t_{\Delta} < 300 \text{ ms}$	$t_{\Delta} < 150 \text{ ms}$	$t_{\Delta} < 40 \text{ ms}$
Selective (time-delayed) RCDs	$t_{\Delta} > 500 \text{ ms}$	$130 \text{ ms} < t_{\Delta} < 500 \text{ ms}$	$60 \text{ ms} < t_{\Delta} < 200 \text{ ms}$	$50 \text{ ms} < t_{\Delta} < 150 \text{ ms}$

Trip-out times according to BS 7671:

	$\frac{1}{2} \times I_{\Delta N}^{*)}$	$I_{\Delta N}$	$2 \times I_{\Delta N}$	$5 \times I_{\Delta N}$
General (non-delayed) RCDs	$t_{\Delta} > 1999 \text{ ms}$	$t_{\Delta} < 300 \text{ ms}$	$t_{\Delta} < 150 \text{ ms}$	$t_{\Delta} < 40 \text{ ms}$
Selective (time-delayed) RCDs	$t_{\Delta} > 1999 \text{ ms}$	$130 \text{ ms} < t_{\Delta} < 500 \text{ ms}$	$60 \text{ ms} < t_{\Delta} < 200 \text{ ms}$	$50 \text{ ms} < t_{\Delta} < 150 \text{ ms}$

^{*)} Test current of $\frac{1}{2} \times I_{\Delta N}$ cannot cause trip-out of the RCDs.

For additional information concerning trip-out time measurement refer to the Metrel handbook *Measurements on electric installations in theory and practice*.

How to perform trip-out time measurement

Step 1 Select the **RCD** function with the function selector switch and use the Δ/∇ keys to select the **Trip-out time** function (RCDt). The following menu will be displayed:



Figure 5.17: Trip-out time measurement menu

Step 2 Set the following measuring parameters:

- ❑ Nominal differential trip-out current,
- ❑ Nominal differential trip-out current multiplier,
- ❑ RCD type, and
- ❑ Test current starting polarity.

Step 3 Connect the leads to the instrument and follow the connection diagram shown in figure 5.15 (see the chapter 5.3.6 *Contact voltage*) to perform trip-out time measurement.

Step 4 Check for any warnings and check the online voltage/terminal monitor on the display before starting measurement. If everything is ok, press the TEST key. After performing the measurement, results will appear on the display along with a PASS/FAIL indication.



Figure 5.18: Example of trip-out time measurement results

Displayed results:

t Trip-out time,
U_c Contact voltage.

Notes:

- ❑ Parameters set in this function are also transferred onto all other RCD functions!
- ❑ RCD trip-out time measurement will be performed only if the contact voltage at nominal differential current is lower than the limit set in the contact voltage setting!
- ❑ The measurement of the contact voltage in pre-test does not normally trip an RCD. However, the trip limit may be exceeded as a result of leakage current flowing through the PE protective conductor or a capacitive connection between L and PE conductors.

5.3.8 Trip-out current

This test is used to determine the minimum current required to trip the RCD. After the measurement has been started, the test current generated by the instrument is continuously increased, starting at $0.2 \times I_{\Delta N}$ to $1.1 \times I_{\Delta N}$ (to $1.5 \times I_{\Delta N}$ / $2.2 \times I_{\Delta N}$ ($I_{\Delta N} = 10$ mA) for pulsating DC residual currents), until the RCD trips.

For additional information concerning the trip-out current measurement, refer to Metrel's handbook *Measurements on electric installations in theory and practice*.

How to perform trip-out current measurement

Step 1 Select **RCD** function with the function selector and use the Δ/∇ keys to select the **Trip-out current** (RCD Δ) function. The following menu is displayed:



Figure 5.19: Trip-out current measurement menu

Step 2 By using cursor keys the following parameters can be set in this measurement:

- ☐ Nominal residual current,
- ☐ RCD type,
- ☐ Test current starting polarity.

Step 3 Connect the test leads to the instrument and follow the connection diagram shown in figure 5.15 (see the chapter 5.3.6 *Contact voltage*) to perform trip-out current measurements.

Step 4 Check for any warnings and check the online voltage/terminal monitor shown on the display before starting the measurement. If everything is ok, press the TEST key. After performing the measurement, the results will be displayed along with a PASS/FAIL indication.



Figure 5.20: Example of trip-out current measurement result

Displayed results:

I_{Δ} Trip-out current,
 U_{ci} Contact voltage,
 tI Trip-out time.

Notes:

- ☐ Parameters set in this function are also kept for other RCD functions!
- ☐ RCD trip-out current measurement will be performed only if the contact voltage at nominal differential current is lower than set limit contact voltage!
- ☐ The measurement of contact voltage in the pre-test does not normally trip an RCD. However, the trip limit may be exceeded as a result of leakage current flowing through the PE protective conductor or a capacitive connection between L and PE conductors.

5.3.9 Autotest

The purpose of the autotest function is to perform a complete RCD testing and measurement of most important associated parameters (contact voltage, fault loop resistance and trip-out time at different fault currents) with one press of a button. If a faulty parameter is noticed during the autotest, the test will stop to highlight the need for further investigation.

Notes:

- ❑ The measurement of contact voltage in the pre-test does not normally trip an RCD. However, the trip limit may be exceeded as a result of leakage current flowing through the PE protective conductor or a capacitive connection between L and PE conductors.
- ❑ The autotest sequence stops when the trip-out time is out of allowed time period.

5.3.9.1 How to perform RCD autotest

Step 1 Select **RCD** function with the function selector switch first. Use the Δ/∇ keys to select **RCD autotest** function (AUTO). The following menu is displayed:

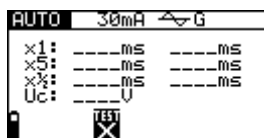


Figure 5.21: RCD autotest menu

Step 2 Set the following measuring parameters:

- ❑ Nominal differential trip-out current,
- ❑ RCD type.

Step 3 Connect the test leads to the instrument and follow the connection diagram shown in figure 5.15 (also see the chapter 5.3.6 *Contact voltage*) to perform the RCD autotest.

Step 4 Check for any warnings and check the online voltage/terminal monitor displayed on the screen before starting the measurement. If everything is ok, press the TEST key. The autotest sequence will then start to run as follows:

1. Trip-out time measurement with the following measurement parameters:

- ❑ Test current of $I_{\Delta N}$,
- ❑ Test current started with the positive half-wave at 0° .

Measurement normally trips an RCD within allowed time period. The following menu is displayed:

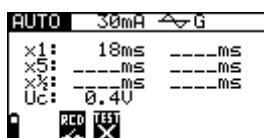


Figure 5.22: Step 1 RCD autotest results

After re-activating the RCD, the autotest sequence automatically proceeds with step 2.

2. Trip-out time measurement with the following measurement parameters:

- ❑ Test current of $I_{\Delta N}$,
- ❑ Test current started with the negative half-wave at 180° .

Measurement normally trips an RCD. The following menu is displayed:

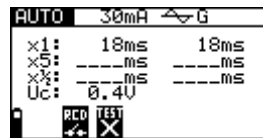


Figure 5.23: Step 2 RCD autotest results

After re-activating the RCD, the autotest sequence automatically proceeds with step 3.

3. Trip-out time measurement with the following measurement parameters:

- ❑ Test current of $5 \times I_{\Delta N}$,
- ❑ Test current started with the positive half-wave at 0° .

Measurement normally trips an RCD within allowed time period. The following menu is displayed:

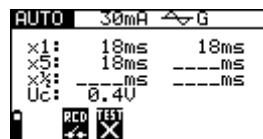


Figure 5.24: Step 3 RCD autotest results

After re-activating the RCD the autotest sequence automatically proceeds with step 4.

4. Trip-out time measurement with the following measurement parameters:

- ❑ Test current of $5 \times I_{\Delta N}$,
- ❑ Test current started with the negative half-wave at 180° .

Measurement normally trips an RCD within allowed time period. The following menu is displayed:

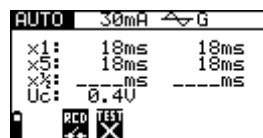


Figure 5.25: Step 4 RCD autotest results

After re-activating the RCD the autotest sequence automatically proceeds with step 5.

5. Trip-out time measurement with the following measurement parameters:

- Test current of $\frac{1}{2} \times I_{\Delta N}$,
- Test current started with the positive half-wave at 0° .

Measurement does not normally trip an RCD. The following menu is displayed:



Figure 5.26: Step 5 RCD autotest results

After performing step 5 the RCD autotest sequence automatically proceeds with step 6.

6. Trip-out time measurement with the following measurement parameters:

- Test current of $\frac{1}{2} \times I_{\Delta N}$,
- Test current started with the negative half-wave at 180° .

Measurement does not normally trip an RCD. The following menu is displayed:



Figure 5.27: Step 6 RCD autotest results

Displayed results:

x1 (left) Step 1 trip-out time result, $t_3 (I_{\Delta N}, 0^\circ)$,
x1 (right) Step 2 trip-out time result, $t_4 (I_{\Delta N}, 180^\circ)$,
x5 (left) Step 3 trip-out time result, $t_5 (5 \times I_{\Delta N}, 0^\circ)$,
x5 (right) Step 4 trip-out time result, $t_6 (5 \times I_{\Delta N}, 180^\circ)$,
x $\frac{1}{2}$ (left) Step 5 trip-out time result, $t_1 (\frac{1}{2} \times I_{\Delta N}, 0^\circ)$,
x $\frac{1}{2}$ (right) ... Step 6 trip-out time result, $t_2 (\frac{1}{2} \times I_{\Delta N}, 180^\circ)$,
Uc Contact voltage.

Note:

- In case of testing the RCD type A with rated residual currents of $I_{\Delta n} = 300 \text{ mA}$, 500 mA , and 1000 mA , the **x5** Auto tests will be automatically skipped. In this case, the auto test result passes if the t_1 to t_4 results pass, and on the display are omitted t_5 and t_6 .

5.4 Fault loop impedance and prospective fault current

The loop impedance function has two sub-functions available:

Z LOOP sub-function performs a fast fault loop impedance measurement on supply systems which do not contain RCD protection.

Z LOOP(rcd) trip-lock sub-function performs fault loop impedance measurement on supply systems which are protected by RCDs..

5.4.1 Fault loop impedance

The fault loop impedance measures the impedance of the fault loop in the event that a short-circuit to an exposed conductive parts occurs (i.e. a conductive connection occurs between the phase conductor and protective earth conductor). In order to measure loop impedance the instrument uses a high test current.

Prospective fault current (IPFC) is calculated on the basis of the measured resistance as follows:

$$I_{PFC} = \frac{U_N \times \text{scaling factor}}{Z_{L-PE}}$$

Where:

Nominal input voltage U_N	Voltage range
115 V	$(100 \text{ V} \leq U_{L-PE} < 160 \text{ V})$
230 V	$(160 \text{ V} \leq U_{L-PE} \leq 264 \text{ V})$

For additional information concerning fault loop impedance measurement refer to Metrel's handbook *Measurements on electric installations in theory and practice*.

5.4.1.1 How to perform fault loop impedance measurement

Step 1 Select the **LOOP** function with the function selector switch and use the $\blacktriangle/\blacktriangledown$ keys to select the **Z LOOP** sub-function. The following menu is displayed:



Figure 5.28: Loop impedance measurement menu

Step 2 Connect the test leads to the instrument and follow the connection diagram shown in the figure 5.29 to perform fault loop impedance measurement.

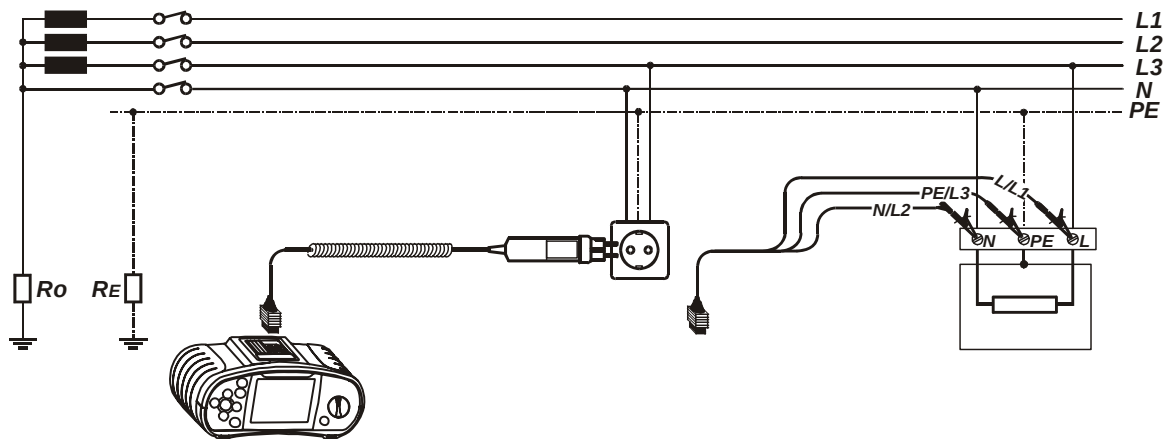


Figure 5.29: Connection of plug cable and universal test cable

Step 3 Check for any warnings displayed on the screen and check the online voltage/terminal monitor before starting the measurement. If everything is ok, press the TEST key. After performing the measurement, the test results will appear on the display.



Figure 5.30: Example of loop impedance measurement results

Displayed results:

Z Fault loop impedance,

I_{sc} Prospective fault current (displayed in amps),

Notes:

- ❑ The specified accuracy of test parameters is valid only if mains voltage is stable during the measurement.
- ❑ The Fault loop impedance measurement trips RCD protected circuits.

5.4.2 The fault loop impedance test for RCD protected circuits

The fault loop impedance is measured with a low test current to avoid tripping the RCD. This function can also be used for fault loop impedance measurement in system equipped with RCDs which have a rated trip-out current of 10 mA and above.

Prospective fault current (IPFC) is calculated on basis of measured resistance as follows:

$$I_{PFC} = \frac{U_N \times \text{scaling factor}}{Z_{L-PE}}$$

Where:

Nominal input voltage U_N	Voltage range
115 V	$(100 \text{ V} \leq U_{L-PE} < 160 \text{ V}),$
230 V	$(160 \text{ V} \leq U_{L-PE} \leq 264 \text{ V}),$

For additional information concerning fault loop impedance measurement refer to Metrel's handbook *Measurements on electric installations in theory and practice*.

5.4.2.1 How to perform RCD trip-lock measurement

Step 1 Select the **LOOP** function with the function selector switch and use the Δ/∇ keys to select **Z LOOP (rcd)** sub-function. The following menu is displayed:



Figure 5.31: Trip-lock function menu

Step 2 Connect the appropriate test leads to the instrument and follow the connection diagram shown in figure 5.15 to perform RCD trip-lock measurement (see chapter 5.3.6 *Contact voltage*).

Step 3 Check for warnings on the display and check the online voltage/terminal monitor before starting the measurement. If everything is ok, press the TEST key. After performing the measurement the results will appear on the display.



Figure 5.32: Example of fault loop impedance measurement results using trip-lock function

Displayed result:

Z Fault loop impedance,
I_{sc} Prospective fault current,

Notes:

- ❑ The measurement of fault loop impedance using trip-lock function does not normally trip an RCD. However, if the trip limit may be exceeded as a result of leakage current flowing through the PE protective conductor or a capacitive connection between L and PE conductors.
- ❑ The specified accuracy of test parameter is valid only if mains voltage is stable during the measurement.

5.5 Line impedance and prospective short-circuit current

The line impedance is a measurement of the impedance of the current loop when a short-circuit to the neutral conductor occurs (conductive connection between phase conductor and neutral conductor in single-phase system or between two phase conductors in three-phase system). A high test current is used to perform the line impedance measurement.

Prospective short circuit current is calculated as follows:

$$I_{PSC} = \frac{U_N \cdot \text{scaling_factor}}{Z_{L-N(L)}}$$

Where:

Nominal input voltage U_N	Voltage range
115 V	$(100 \text{ V} \leq U_{L-PE} < 160 \text{ V})$
230 V	$(160 \text{ V} \leq U_{L-PE} \leq 264 \text{ V})$
400 V	$(264 \text{ V} < U_{L-PE} \leq 440 \text{ V})$

For additional information concerning line impedance refer to Metrel's handbook *Measurements on electric installations in theory and practice*.

How to perform line impedance measurement

Step 1 Select the **LINE** function with function selector switch. The following menu is displayed:



Figure 5.33: Line impedance measurement menu

Step 2 Connect the appropriate test leads to the instrument and follow the connection diagram shown in figure 5.34 to perform phase-neutral or phase-phase line impedance measurement.

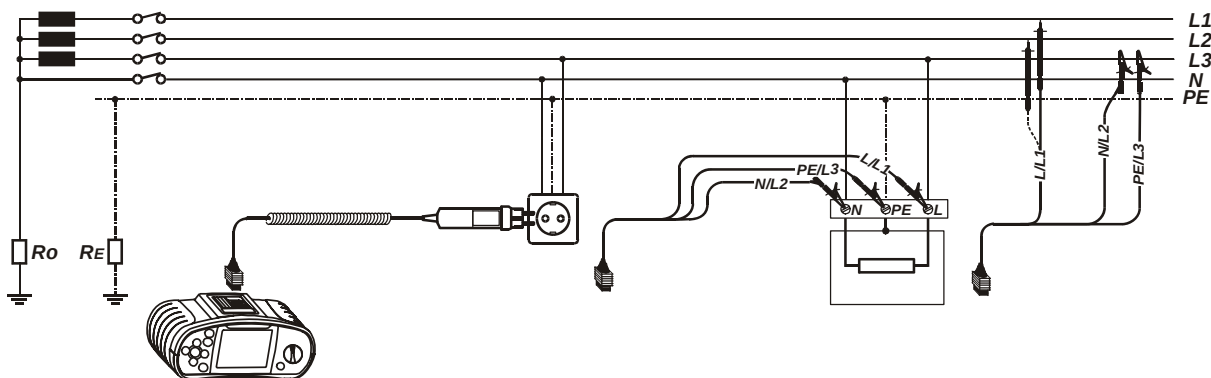


Figure 5.34: Phase-neutral or phase-phase line impedance measurement

Step 3 Check for warnings displayed on the screen and check the online voltage/terminal monitor before starting the measurement. If everything is ok, press the TEST key. After performing the measurement, the results will appear on the display.



Figure 5.35: Example of line impedance measurement results

Displayed results:

Z Line impedance,

I_{sc} Prospective short-circuit current,

Notes:

- The specified accuracy of the test parameter is valid only if mains voltage is stable during the measurement.

5.6 Phase sequence testing

In practice, we often deal with the connection of three-phase loads (motors and other electro-mechanical machines) to three-phase mains installation. Some loads (ventilators, conveyors, motors, electro-mechanical machines, etc.) require a specific phase rotation and some may even be damaged if the rotation is reversed. This is why it is advisable to test phase rotation before connection is made.

For information concerning phase sequence testing refer to Metrel's handbook *Measurements on electric installations in theory and practice*.

How to test the phase sequence

Step 1 Select the **PHASE ROTATION** function (↻) with the function selector switch. The following menu is displayed.

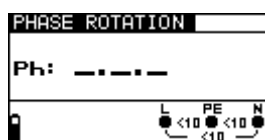


Figure 5.36: Phase rotation test menu

Step 2 Connect test cable to the EasiPLUS instrument and follow the connection diagram shown in figure 5.37 to test phase sequence.

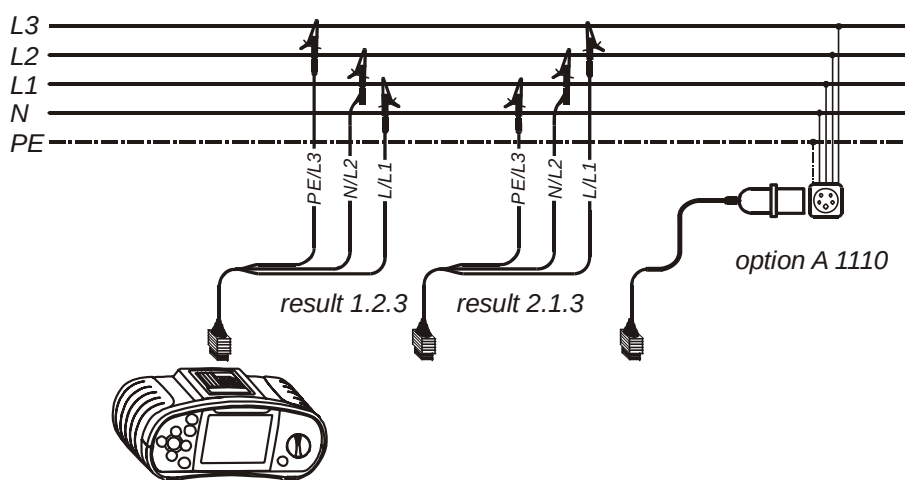


Figure 5.37: Connection of universal test cable and optional three phase cable

Step 3 Check for warnings on the display and check the online voltage/terminal monitor. The phase sequence test is a continuously running test hence the results will be displayed as soon as the full test lead connection to the item under test has been made.. All three-phase voltages are displayed in order of their sequence represented by the numbers 1, 2 and 3.

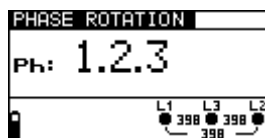


Figure 5.38: Example of phase sequence test result

Displayed results:

Ph.....Phase sequence,
1.2.3.....Correct connection,
2.3.1.....Invalid connection,
-.-.....Irregular voltages.

5.7 Voltage and frequency

Voltage measurements should be carried out regularly while dealing with electric installations (carrying out different measurements and tests, looking for fault locations, etc.). Frequency is measured for example when establishing the source of mains voltage (power transformer or individual generator).

How to perform voltage and frequency measurement

Step 1 Select the **VOLTAGE** function (Volt.) with the function selector switch. The following menu is displayed:

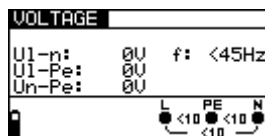


Figure 5.39: Voltage and frequency measurement menu

Step 2 Connect test cable to the EasiPLUS instrument and follow the connection diagram shown in figure 5.40 to perform a voltage and frequency measurement.

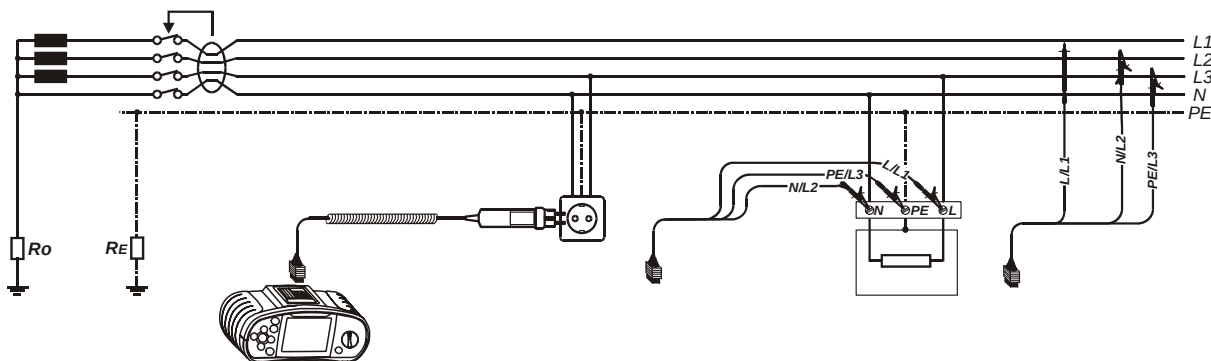


Figure 5.40: Connection diagram

Step 3 Check the displayed warnings. The Voltage and Frequency test continually runs, showing fluctuations as they occur, these results are shown on the display during measurement.



Figure 5.41: Examples of voltage and frequency measurements

Displayed results:

U1-n..... Voltage between phase and neutral conductors,

U1-pe..... Voltage between phase and protective conductors,

Un-pe Voltage between neutral and protective conductors.

When testing three-phase system the following results are displayed:

U1-2..... Voltage between phases L1 and L2,

U1-3..... Voltage between phases L1 and L3,

U2-3..... Voltage between phases L2 and L3.

5.8 Testing the PE terminal

In new or adapted installations it may occur that the position of the PE conductor and the phase conductor become reversed – this is a very dangerous situation! This is why it is important to test for the presence of a phase voltage on the PE protection terminal. This test should be performed before a mains supply voltage is applied to the instrument circuitry and before installation is used.

For additional information concerning PE terminal test, refer to Metrel's handbook *Measurements on electric installations in theory and practice*.

How to test PE terminal

Step 1 Connect test cable to the instrument.

Step 2 Follow the connection diagrams shown in figures 5.42 and 5.43 to test PE terminal.

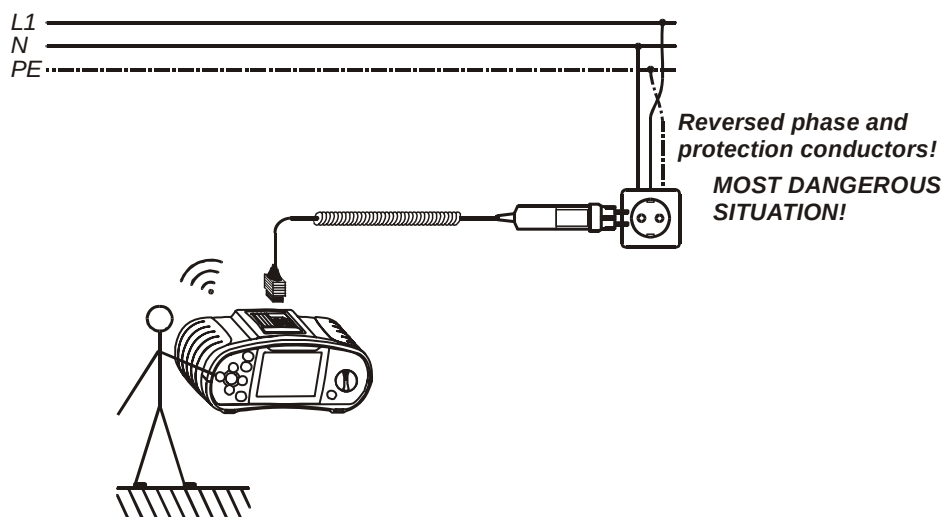


Figure 5.42: Connection of plug cable to mains outlet with reversed L and PE conductors

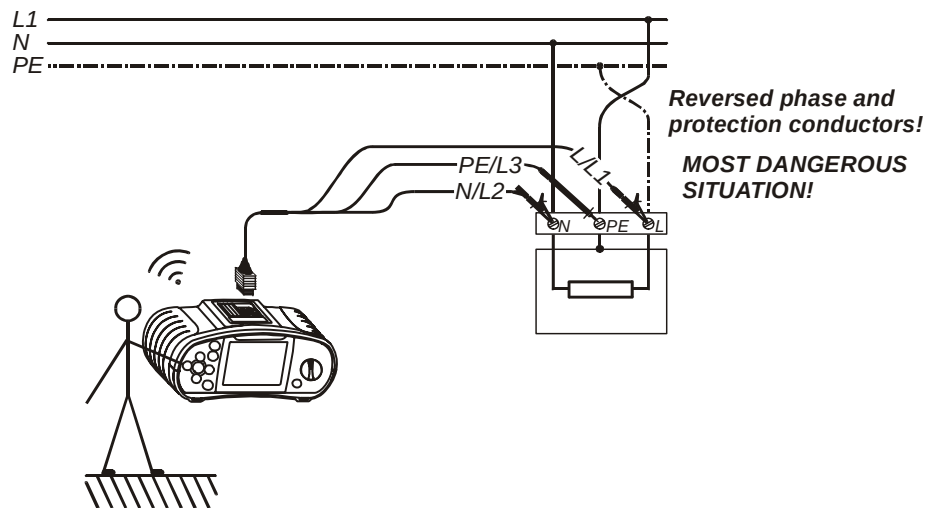


Figure 5.43: Connection of universal test cable to load connection terminals with reversed L and PE conductors

Step 3 Touch the PE test probe (TEST key) for a few seconds. If PE terminal is connected to phase voltage a warning message will be displayed and instrument buzzer will sound.

Warning:

- ❑ If phase voltage is detected on tested PE terminal, stop all measurements immediately and remove the cause of the fault before proceeding with any activity!

Notes:

- ❑ The PE terminal can only be tested with the function selector set to RCD, LOOP or LINE!
- ❑ For correct testing of PE terminals, the TEST key has to be touched for a few seconds.
- ❑ When testing, make sure the instrument operated is stood on non-isolated floor (otherwise the test result may be wrong!)

6 Maintenance

6.1 Replacing fuses

There are three fuses under back battery cover of the EasiPLUS instrument.

- ❑ F1
M 0.315 A / 250 V, 20×5 mm
This fuse protects internal circuitry of low-value resistance function if test probes are connected to the mains supply voltage by mistake.
- ❑ F2, F3
F 4 A / 500 V, 32×6.3 mm
General input protection fuses for the L/L1 and N/L2 test terminals.

Warnings:

- ❑  Disconnect any measuring accessory from the instrument and ensure that the instrument is turned off before opening the battery/fuse compartment cover, hazardous voltage can exist inside this compartment!
- ❑ Replace any blown fuses with exactly the same type of fuse. The instrument can be damaged and/or operator's safety impaired if this is not performed!

The Position of fuses can be seen in figure 3.4 in chapter 3.3 Back panel.

6.2 Cleaning

No special maintenance is required for the housing. To clean the surface of the instrument use a soft cloth slightly moistened with soapy water or alcohol. Then leave the instrument to dry totally before use.

Warnings:

- ❑ Do not use liquids based on petrol or hydrocarbons!
- ❑ Do not spill cleaning liquid over the instrument!

6.3 Periodic calibration

It is essential that the test instrument is regularly calibrated in order for the technical specification listed in this manual to be guaranteed. We recommend an annual calibration. The calibration should be done by an authorised technical person only. Please contact your dealer for further information.

6.4 Service

For repairs under warranty, or at any other time, please contact your distributor. Unauthorised person(s) are not allowed to open the EasiPLUS instrument. There are no user replaceable components inside the instrument, except for the three fuses inside the battery compartment, refer to chapter 6.1 *Replacing fuses*.

7 Technical specifications

7.1 Insulation resistance

Insulation resistance (nominal voltages 100 V_{DC} and 250 V_{DC})

Measuring range according to EN61557-2 is 0.017 MΩ ÷ 199.9 MΩ.

Measuring range (MΩ)	Resolution (MΩ)	Accuracy
0.000 ÷ 1.999	0.001	±(5 % of reading + 3 digits)
2.00 ÷ 99.99	0.01	
100.0 ÷ 199.9	0.1	

Insulation resistance (nominal voltages 500 V_{DC} and 1000 V_{DC})

Measuring range according to EN61557-2 is 0.015 MΩ ÷ 999 MΩ.

Measuring range (MΩ)	Resolution (MΩ)	Accuracy
0.000 ÷ 1.999	0.001	±(2 % of reading + 3 digits)
2.00 ÷ 99.99	0.01	
100.0 ÷ 199.9	0.1	
200 ÷ 999	1	±(10 % of reading)

Voltage

Measuring range (V)	Resolution (V)	Accuracy
0 ÷ 1200	1	±(3 % of reading + 3 digits)

Nominal voltages 100 V_{DC}, 250 V_{DC}, 500 V_{DC}, 1000 V_{DC}

Open circuit voltage -0 % / +20 % of nominal voltage

Measuring current..... min. 1 mA at R_N=U_N×1 kΩ/V

Short circuit current..... max. 3 mA

Specified accuracy is valid if universal test cable is used, while it is valid up to 200 MΩ if tip commander is used.

The number of possible tests

with a new set of batteries up to 1800

Auto discharge after test.

In case the instrument gets moistened the results could be impaired. In such case it is recommended to dry the instrument and accessories for at least 24 hours.

7.2 Continuity resistance

7.2.1 LowΩ

Measuring range according to EN61557-4 is 0.16 Ω ÷ 1999 Ω.

Measuring range (Ω)	Resolution (Ω)	Accuracy
0.00 ÷ 19.99	0.01	±(3 % of reading + 3 digits)
20.0 ÷ 99.9	0.1	±(5 % of reading)
100 ÷ 1999	1	

Open-circuit voltage..... $6.5 V_{DC} \div 9 V_{DC}$
 Measuring current..... min. 200 mA into load resistance of 2Ω
 Test lead compensation..... up to 5Ω
 The number of possible tests
 with a new set of batteries up to 5500
 Automatic polarity reversal of the test voltage.

7.2.2 Low current continuity

Measuring range (Ω)	Resolution (Ω)	Accuracy
0.0 ÷ 99.9	0.1	$\pm(5 \% \text{ of reading} + 3 \text{ digits})$
100 ÷ 1999	1	

Open-circuit voltage..... $6.5 V_{DC} \div 9 V_{DC}$
 Short-circuit current max. 8.5 mA
 Test lead compensation..... up to 5Ω

7.3 RCD testing

7.3.1 General data

Nominal residual current..... 10 mA, 30 mA, 100 mA, 300 mA, 500 mA, 1000 mA
 Nominal residual current accuracy.... $-0 / +0.1 \cdot I_{\Delta}$; $I_{\Delta} = I_{\Delta N}, 2 \times I_{\Delta N}, 5 \times I_{\Delta N}$
 $-0.1 \cdot I_{\Delta} / +0$; $I_{\Delta} = \frac{1}{2} \times I_{\Delta N}$
 Test current shape..... Sine-wave (AC), pulsed (A)
 RCD type general (G, non-delayed), selective (S, time-delayed)
 Test current starting polarity 0° or 180°
 Voltage range 100 V ÷ 264 V (45 Hz ÷ 65 Hz)

RCD test current selection (r.m.s. value calculated to 20 ms) according to IEC 61009:

$I_{\Delta N}$ (mA)	$\frac{1}{2} \times I_{\Delta N}$		$1 \times I_{\Delta N}$		$2 \times I_{\Delta N}$		$5 \times I_{\Delta N}$		RCD I_{Δ}	
	AC	A	AC	A	AC	A	AC	A	AC	A
10	5	3,5	10	20	20	40	50	100	✓	✓
30	15	10,5	30	42	60	84	150	212	✓	✓
100	50	35	100	141	200	282	500	707	✓	✓
300	150	105	300	424	600	848	1500	*)	✓	✓
500	250	175	500	707	1000	1410	2500	*)	✓	✓
1000	500	350	1000	1410	2000	*)	*)	*)	✓	✓

*) not available

7.3.2 Contact voltage

Measuring range according to EN61557-6 is 3.0 V ÷ 49.0 V for limit contact voltage 25 V.

Measuring range according to EN61557-6 is 3.0 V ÷ 99.0 V for limit contact voltage 50 V.

Measuring range (V)	Resolution (V)	Accuracy
0.0 ÷ 9.9	0.1	(-0 % / +10 %) of reading + 2 digits
10.0 ÷ 99.9	0.1	(-0 % / +10 %) of reading

Accuracy applies for 1 year in reference conditions. Temperature coefficient outside these limits is +1 digit.

Test current max. $0.5 \times I_{\Delta N}$

Limit contact voltage 25 V, 50 V

Fault loop resistance at contact voltage is calculated as $R_L = \frac{U_C}{I_{\Delta N}}$.

7.3.3 Trip-out time

Complete measurement range corresponds to EN61557-6 requirements. Specified accuracies are valid for complete operating range.

General (non-delayed) RCDs

Measuring range (ms)	Resolution (ms)	Accuracy
0 ÷ 300 ($\frac{1}{2} \times I_{\Delta N}$, $I_{\Delta N}$)	1	±3 ms
0 ÷ 150 ($2 \times I_{\Delta N}$)	1	
0 ÷ 40 ($5 \times I_{\Delta N}$)	1	

Selective (time-delayed) RCDs

Measuring range (ms)	Resolution (ms)	Accuracy
0 ÷ 500 ($\frac{1}{2} \times I_{\Delta N}$, $I_{\Delta N}$)	1	±3 ms
0 ÷ 200 ($2 \times I_{\Delta N}$)	1	
0 ÷ 150 ($5 \times I_{\Delta N}$)	1	

Test current $\frac{1}{2} \times I_{\Delta N}$, $I_{\Delta N}$, $2 \times I_{\Delta N}$, $5 \times I_{\Delta N}$

Multiplier 5 is not available if $I_{\Delta N} = 1000$ mA (AC type RCDs) or $I_{\Delta N} \geq 300$ mA (A type RCDs).

Multiplier 2 is not available if $I_{\Delta N} = 1000$ mA (A type RCDs).

7.3.4 Trip-out current

Trip-out current ($I_{\Delta N} = 10$ mA)

Measurement range corresponds to EN61557-6 requirements. Specified accuracies are valid for complete operating range.

Measuring range I_{Δ}	Resolution I_{Δ}	Accuracy
$0.2 \times I_{\Delta N} \div 1.1 \times I_{\Delta N}$ (AC type)	$0.05 \times I_{\Delta N}$	$\pm 0.1 \times I_{\Delta N}$
$0.2 \times I_{\Delta N} \div 2.2 \times I_{\Delta N}$ (A type)	$0.05 \times I_{\Delta N}$	$\pm 0.1 \times I_{\Delta N}$

Trip-out current ($I_{\Delta N} \geq 30$ mA)

Measurement range corresponds to EN61557-6 requirements. Specified accuracies are valid for complete operating range.

Measuring range I_{Δ}	Resolution I_{Δ}	Accuracy
$0.2 \times I_{\Delta N} \div 1.1 \times I_{\Delta N}$ (AC type)	$0.05 \times I_{\Delta N}$	$\pm 0.1 \times I_{\Delta N}$
$0.2 \times I_{\Delta N} \div 1.5 \times I_{\Delta N}$ (A type)	$0.05 \times I_{\Delta N}$	$\pm 0.1 \times I_{\Delta N}$

Trip-out time

Measuring range (ms)	Resolution (ms)	Accuracy
0 ÷ 300	1	± 3 ms

Contact voltage

Measuring range (V)	Resolution (V)	Accuracy
0.0 ÷ 9.9	0.1	(-0 % / +10 %) of reading + 2 digits
10.0 ÷ 99.9	0.1	(-0 % / +10 %) of reading

7.4 Fault loop impedance and prospective fault current

Zs sub-function

Measuring range according to EN61557-3 is $0.25 \Omega \div 1999 \Omega$.

Measuring range (Ω)	Resolution (Ω)	Accuracy
0.00 ÷ 19.99	0.01	$\pm(5 \text{ \% of reading} + 5 \text{ digits})$
20.0 ÷ 99.9	0.1	
100 ÷ 1999	1	

Prospective fault current (calculated value)

Measuring range (A)	Resolution (A)	Accuracy
0.00 ÷ 19.99	0.01	Consider accuracy of fault loop resistance measurement
20.0 ÷ 99.9	0.1	
100 ÷ 999	1	
1.00k ÷ 9.99k	10	
10.0 ÷ 24.4k	100	

Test current (at 230 V)..... 7.5 A ($10 \text{ ms} \leq t_{\text{LOAD}} \leq 15 \text{ ms}$)

Nominal voltage range..... 100 V ÷ 264 V (45 Hz ÷ 65 Hz)

Zs(rcd) trip-lock sub-function

Measuring range according to EN61557 is $0.46 \Omega \div 1999 \Omega$.

Measuring range (Ω)	Resolution (Ω)	Accuracy ^{*)}
0.00 ÷ 19.99	0.01	$\pm(5 \text{ \% of reading} + 10 \text{ digits})$
20.0 ÷ 99.9	0.1	$\pm 10 \text{ \% of reading}$
100 ÷ 1999	1	$\pm 10 \text{ \% of reading}$

^{*)} Accuracy may be impaired in case of heavy noise on mains voltage.

Prospective fault current (calculated value)

Measuring range (A)	Resolution (A)	Accuracy
0.00 ÷ 19.99	0.01	Consider accuracy of fault loop resistance measurement
20.0 ÷ 99.9	0.1	
100 ÷ 999	1	
1.00k ÷ 9.99k	10	
10.0 ÷ 24.4k	100	

No trip out of RCD.

7.5 Line impedance and prospective short-circuit current

Line impedance

Measuring range according to EN61557-3 is 0.25 Ω ÷ 1999 Ω.

Measuring range (Ω)	Resolution (Ω)	Accuracy
0.00 ÷ 19.99	0.01	±(5 % of reading + 5 digits)
20.0 ÷ 99.9	0.1	
100 ÷ 1999	1	

Prospective short-circuit current (calculated value)

Measuring range (A)	Resolution (A)	Accuracy
0.00 ÷ 19.99	0.01	Consider accuracy of line resistance measurement
20.0 ÷ 99.9	0.1	
100 ÷ 999	1	
1.00k ÷ 9.99k	10	
10.0 ÷ 24.4k	100	

Test current (at 230 V) 7.5 A (10 ms ≤ t_{LOAD} ≤ 15 ms)

Nominal voltage range 100 V ÷ 440 V (45 Hz ÷ 65 Hz)

7.6 Phase rotation

Nominal mains voltage range 100 V_{AC} ÷ 440 V_{AC}

Nominal frequency range 45 Hz ÷ 65 Hz

Result displayed 1.2.3 or 2.1.3

7.7 Voltage and frequency

Measuring range (V)	Resolution (V)	Accuracy
0 ÷ 500	1	±(2 % of reading + 2 digits)

Nominal frequency range 0 Hz, 45 Hz ÷ 65 Hz

Measuring range (Hz)	Resolution (Hz)	Accuracy
45.0 ÷ 65.0	0.1	± 2 digits

Nominal voltage range 10 V ÷ 500 V

7.8 Online voltage monitor

Measuring range (V)	Resolution (V)	Accuracy
0 ÷ 500	1	±(2 % of reading + 2 digits)

Nominal frequency range..... 0 Hz, 45 Hz ÷ 65 Hz

If voltage greater than 500 V is applied to the test terminals, online voltage monitor is used as voltage indicator only.

7.9 General data

Power supply voltage..... 9 V_{DC} (6×1.5 V battery cells, size AA)

Power supply adapter 12 V ÷ 15 V / 400 mA

Battery charging current < 250 mA (internally regulated)

Operation typical 15 h

Overvoltage category..... CAT III / 600 V; CAT IV / 300 V

Plug commander (optional)

overvoltage category CAT III / 300 V

Protection classification double insulation

Pollution degree..... 2

Protection degree IP 42

Display 128×64 dots matrix display with backlight

Dimensions (w × h × d) 23 cm × 10.3 cm × 11.5 cm

Weight (without battery)..... 1.31 kg

Reference conditions

Reference temperature range 10 °C ÷ 30 °C

Reference humidity range 40 %RH ÷ 70 %RH

Operating conditions

Working temperature range 0 °C ÷ 40 °C

Maximum relative humidity..... 95 %RH (0 °C ÷ 40 °C), non-condensing

Storage conditions

Temperature range -10 °C ÷ +70 °C

Maximum relative humidity..... 90 %RH (-10 °C ÷ +40 °C)

80 %RH (40 °C ÷ 60 °C)

The error in operating conditions could be at most the error for reference conditions (specified in the manual for each function) + 1 % of measured value + 1 digit unless otherwise specified.

A IT supply systems

In order for the operator to be familiar with the measurements and their typical applications on IT supply systems, it is advisable to read Metrel's handbook *Measurements on IT power supply systems*.

A.1 Standard references

EN 60364-4-41, EN 60364-6, EN 60364-7-710, BS 7671

A.2 Fundamentals

An IT supply system is a mains supply system that is insulated from ground (PE) (i.e. it is ungrounded supplying system). The system either has no direct connection to ground or the connection is provided through a relatively high impedance. IT systems mainly occur in areas where additional protection against electric shock is required. Typical places are medical surgery rooms.

IT supply systems also has no grounding currents except leakages, and in this way they are not susceptible to problems with step voltages, (e.g. voltage drops in a step) or high energy sparking in Extrinsic areas.

In normal situations, a high impedance to ground exists and is formed by the capacitances of the supply wires to ground and the capacitances between the primary and secondary windings of the IT supply transformer. A minor part of the capacitance is formed by Y capacitors (EMC) in the mains section of any connected equipment. Selecting the appropriate transformer, installation cabling and the selection of an optional high impedance connection to ground can control the maximum leakage current of the system.

Depending on the application, additional impedances to ground can be applied or can occur through special loading equipment (as presented in *Figure B.1*). The value of the impedance should be greater than 100 Ω .

The IT system can provide an additional level of protection against electric shock. In the situation where a failure occurs in any of the insulation between the line conductors and PE (e.g. through equipment failure, wrong application or procedure), this system will remain safe but will be converted into a TN / TT type system. However, additional failure can be hazardous, which means that the insulation must be continuously checked and repaired immediately after a failure has been detected.

Supplementary to other protection devices, an IT system normally contains insulation monitoring devices (IMD) or systems that sound alarms when insulation resistance or impedance drops below set threshold. The threshold value usually depends on environment and the application. (e.g. Typical value for a medical installations is 55 k Ω). In some countries, it is not enough to trace the insulation resistance of the IT supply system to ground, they require tracing of system capacitance, too.

IEC 60364-4-41 (©IEC): In IT systems, live parts shall be insulated from earth or connected to earth through sufficiently high impedance. This connection may be made

either at the neutral point or at midpoint of the system or at an artificial neutral point. The latter may be connected directly to earth if the resulting impedance to earth is sufficiently high at the system frequency. Where no neutral point or mid-point exists a line conductor may be connected to earth through high impedance.

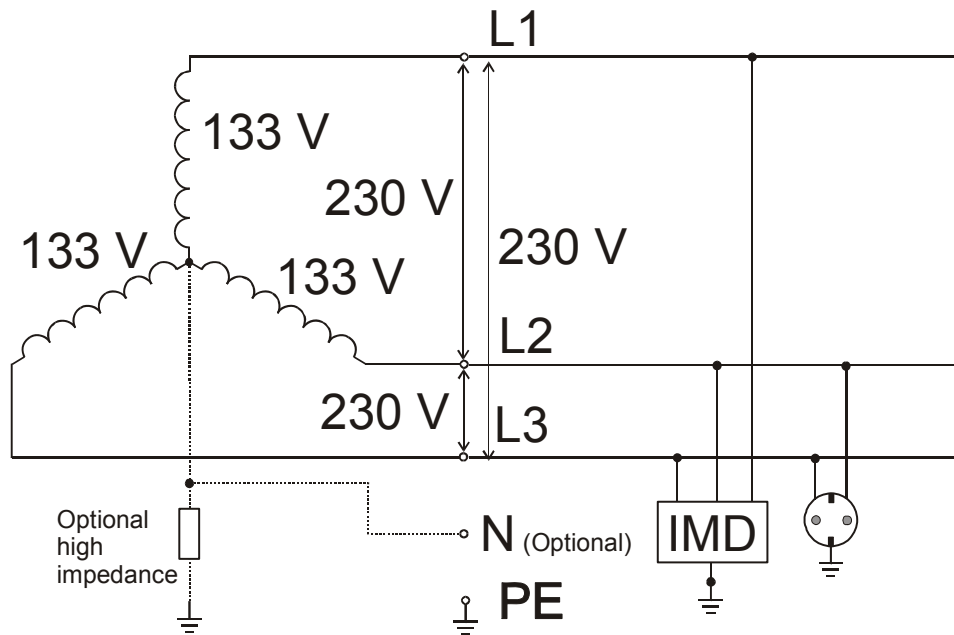


Figure B.1: General IT supply system

- ❑ Three phase star connection, optional delta connection.
- ❑ Optional neutral line.
- ❑ Single-phase connection is also possible.
- ❑ Various system voltages – not only three phase 230 V as indicated above.
- ❑ One faulty connection of any line to PE is treated as first fault and is regular but it has to be repaired as soon as possible.
- ❑ **IEC 60364-4-41:** In IT systems the following monitoring devices and protective devices may be used:
 - Insulation monitoring devices (IMDs),
 - Residual current monitoring devices (RCMs),
 - Insulation fault location systems,
 - Overcurrent protective devices,
 - Residual current protective devices (RCDs).

Note:

- ❑ Where a residual current operating device (RCD) is used, tripping of the RCD in the event of a first fault cannot be excluded due to capacitive leakage currents.

Testing of IT supply system is slightly different to standard tests in TN / TT system.

A.3 Measurement guides

The user has to select the IT supply system in the instrument before testing it. The procedure for selecting the IT supply system is defined in chapter 4.4.1 *Supply system setup*. Once the IT system is selected the instrument can be used immediately. The instrument keeps selected IT system when it is turned off.

The table below contains functions of the instrument including compatibility notes related to IT system.

IT system functions	Notes
Continuity functions	
RLOW Ω	Independent of selected supply system.
Continuity	
Insulation	Independent of selected supply system.
Line impedance	
Line impedance	Impedance Z_{L1-L2} .
Prospective short circuit current	I_{PSC} for rated U_{L1-L2} .
Fault loop impedance	Independent of selected supply system.
Fault loop impedance	
Prospective fault current	
Voltage, frequency	Symbols modified for IT system.
Phase rotation	Three-phase system automatic detected.
RCD functions	Independent of selected supply system.
Contact voltage U_C	
Trip-out time	Bypassing principle shown in figure B.3.
Trip-out current	
Automatic test	
PE test probe	Active, but does not inhibit selected test if voltage is detected.

A.3.1 Voltage

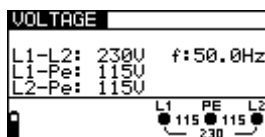


Figure B.2: Example of voltage and frequency measurements

Displayed results for **single phase** system:

L1-L2 Voltage between line conductors,

L1-pe Voltage between line 1 and protective conductor,

L2-pe Voltage between line 2 and protective conductor.

A.3.2 Line impedance

See chapter 5.5 *Line impedance and prospective short-circuit current*, the measurement is the same; only terminal voltage monitor indication corresponds to IT system.

A.3.3 RCD testing

RCD testing is performed in the same way as in TN/TT system (See chapter 5.3 *Testing RCDs*), with the following exception:

- Contact voltage measurement is not relevant.

Test circuit with bypassing principle should correspond to that in figure B.3.

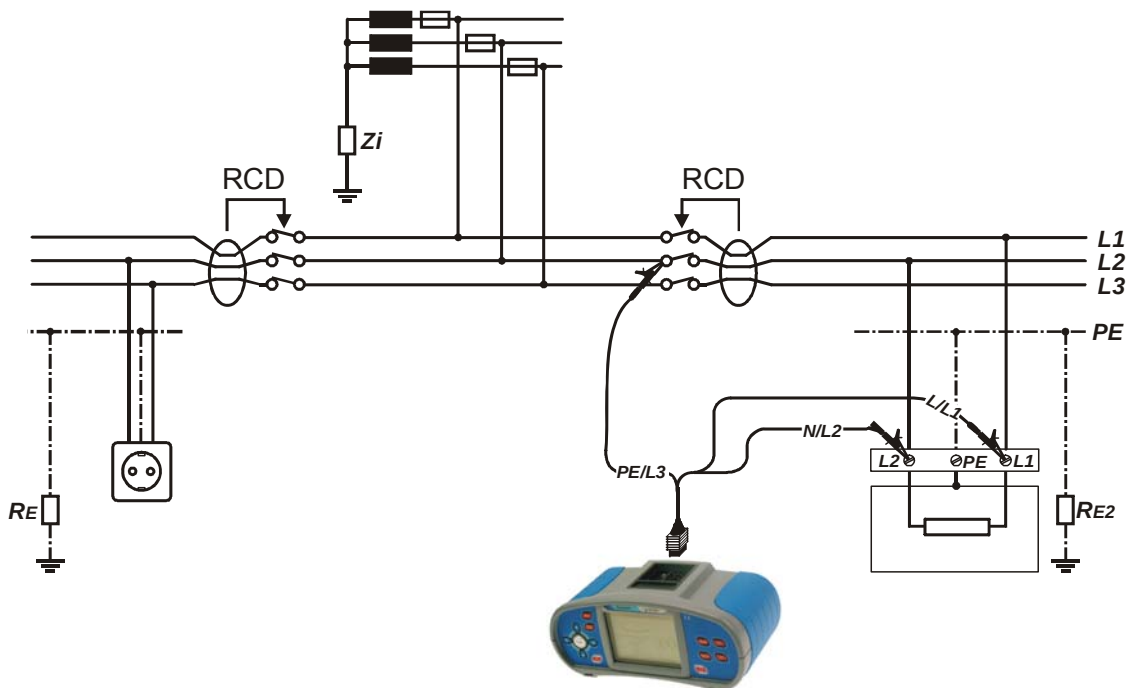


Figure B.3: RCD testing in IT system

B Reduced low voltage supply systems

B.1 Standard reference

- BS7671

B.2 Fundamentals

Special supply systems are applied where inherent protection against electric shock is required but no SELV used. Reduced low voltage supply with ground reference can be used for this purpose.

There are two options with 110 V nominal voltage.

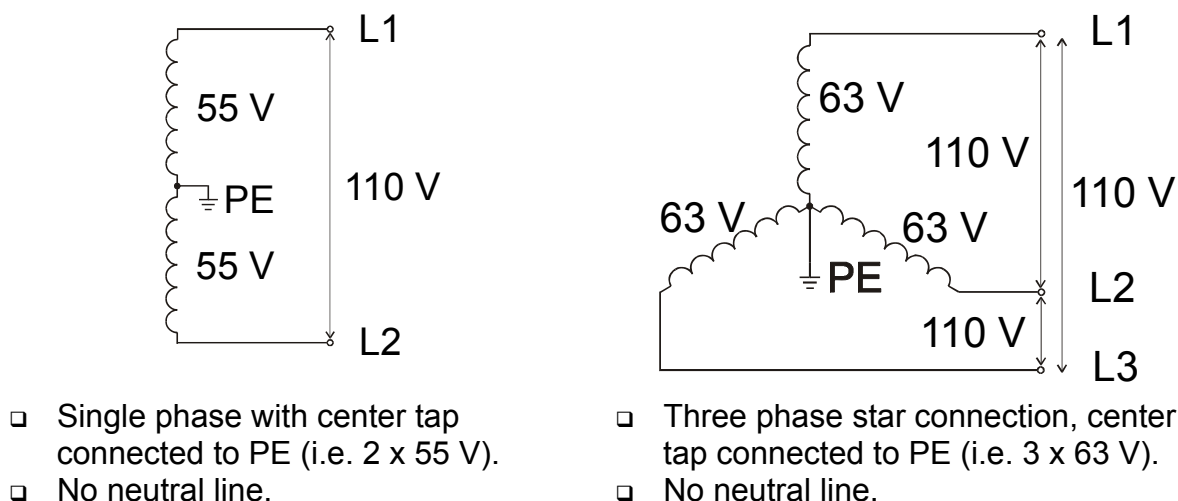


Figure C.1: General reduced low voltage supply systems

B.3 Measurement guides

The user has to select the reduced low voltage supply system in the instrument before testing it. The procedure for selecting the reduced low voltage supply system is defined in chapter 4.4.1 *Supply system setup*. Once the reduced low voltage system is selected, the instrument can be used immediately. The instrument keeps selected reduced low voltage system when it is turned off.

The table below contains instrument functions intended for test and measurement of supply systems with compatibility notes related to the reduced low voltage system.

Reduced low voltage system functions	Notes
Continuity functions	
RLOW Ω	Independent of selected supply system.
Continuity	
Insulation	Independent of selected supply system.

Line resistance	
Line resistance	Resistance R_{L1-L2} .
Prospective short circuit current	I_{PSC} for $U_{L1-L2} = 110\text{ V}$.
Fault loop resistance	
Fault loop resistance	Both fault loops, R_1 (L1-PE) and R_2 (L2-PE).
Prospective fault current	I_{SC1} and I_{SC2} for both fault loops.
Voltage, frequency	Symbols modified for reduced low voltage system.
Phase rotation	Three-phase system automatic detected.
RCD functions	
Contact voltage U_C	For both possibilities, U_1 (L1-PE) and U_2 (L2-PE).
Trip-out time	Maximum nominal differential current limited to 1 A.
Trip-out current	
Automatic test	
PE test probe	Disabled.

B.3.1 Voltage

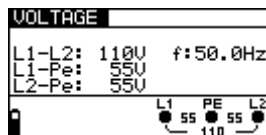


Figure C.2: Example of voltage and frequency measurements

Displayed results for single phase system:

L1-L2 Voltage between line conductors,

L1-pe Voltage between line 1 and protective conductors,

L2-pe Voltage between line 2 and protective conductors.

B.3.2 RCD testing

Maximum regular RCD test current is 1 A r.m.s. (1.4 A peak) and can be achieved only when fault loop resistance is lower than $1\ \Omega$.

Tests are carried out for both combinations (L1-PE and L2-PE) automatically. Each individual test result is accompanied with appropriate indication.

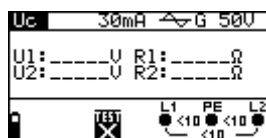


Figure C.3: RCD contact voltage test

B.3.3 Line resistance and prospective short circuit current

Measured resistance represents Line-Line resistance (R_{L1-L2}). Nominal system voltage for calculation of I_{PSC} is set to 110 V.

Nominal system voltage range for line resistance measurement is 90 V to 121 V. If input voltage is out of range it is displayed on terminal voltage monitor, together with the indicator of disabled test .

B.3.4 Fault loop resistance and prospective fault current

The definition of the nominal system voltage for calculating the I_{PFC} changes to:

- 55 V for single-phase centre-tap system selected,
- 63 V for three-phase system selected.

Tests can be carried out for both combination L1-PE and L2-PE. Each individual test result is accompanied with appropriate indication.

Nominal input voltages are:

Nominal input voltage U_N	Voltage range
Single-phase 55 V system	$(44 \text{ V} \leq U < 61 \text{ V}),$
Three-phase 63 V system	$(56 \text{ V} \leq U \leq 70 \text{ V}),$

If an input voltage is out of range, it is displayed on terminal voltage monitor together with the indicator of disabled test .

B.4 Technical specifications

Only those technical specifications are listed below that are different to specifications from chapter 7 of this document.

B.4.1 RCD testing

B.4.2 General data

Nominal residual current.....	10 mA, 30 mA, 100 mA, 300 mA, 500 mA, 1000 mA
Nominal residual current accuracy....	-0 / +0.1·I _Δ ; I _Δ = I _{ΔN} , 2×I _{ΔN} , 5×I _{ΔN} -0.1·I _Δ / +0; I _Δ = 1/2×I _{ΔN}
Maximum nominal differential current for declared accuracy	1000 mA for I _{ΔN} 500 mA for 2×I _{ΔN} 100 mA for 5×I _{ΔN}
Maximum test current	1 A (for Z LOOP < 1 Ω)
Test current shape.....	Sine-wave (AC), pulsed (A)
DC offset for pulsed test current	6 mA typical
RCD type	general (G, non-delayed), selective (S, time-delayed)
Test current starting polarity	0° or 180°
Nominal input voltage	55 V / 63 V (45 Hz ÷ 65 Hz)

B.4.3 Contact voltage

Measuring range according to EN61557-6 is 3.0 V ÷ 32.6 V for limit contact voltage 25 V.

Measuring range according to EN61557-6 is 3.0 V ÷ 66.0 V for limit contact voltage 50 V.

Measuring range (V)	Resolution (V)	Accuracy
0.0 ÷ 9.9	0.1	(-0 % / +15 %) of reading + 2 digits
10.0 ÷ 99.9	0.1	(-0 % / +15 %) of reading

Accuracy applies for 1 year in reference conditions. Temperature coefficient outside these limits is +1 digit.

Test current max. 0.5×I_{ΔN}

Limit contact voltage 25 V or 50 V

The contact voltage is calculated to.. I_{ΔN} (general type) or to 2×I_{ΔN} (selective type)

Fault loop resistance at contact voltage is calculated as $R_L = \frac{U_C}{I_{\Delta N}}$.

Trip-out time

Complete measurement range corresponds to EN61557-6 requirements. Specified accuracies are valid for complete operating range.

General (non-delayed) RCDs

Measuring range (ms)	Resolution (ms)	Accuracy
0 ÷ 300 ($\frac{1}{2} \times I_{\Delta N}$, $I_{\Delta N}$)	1	±3 ms
0 ÷ 150 ($2 \times I_{\Delta N}$)	1	
0 ÷ 40 ($5 \times I_{\Delta N}$)	1	

Selective (time-delayed) RCDs

Measuring range (ms)	Resolution (ms)	Accuracy
0 ÷ 500 ($\frac{1}{2} \times I_{\Delta N}$, $I_{\Delta N}$)	1	±3 ms
0 ÷ 200 ($2 \times I_{\Delta N}$)	1	
0 ÷ 150 ($5 \times I_{\Delta N}$)	1	

Test current $\frac{1}{2} \times I_{\Delta N}$, $I_{\Delta N}$, $2 \times I_{\Delta N}$, $5 \times I_{\Delta N}$

$5 \times I_{\Delta N}$ is not applicable for $I_{\Delta N} \geq 100$ mA (RCD types AC,A)

$2 \times I_{\Delta N}$ is not applicable for $I_{\Delta N} \geq 500$ mA (RCD type AC) or $I_{\Delta N} \geq 300$ mA (RCD type A)

$I_{\Delta N}$ is not applicable for $I_{\Delta N} = 1000$ mA (RCD type AC) or $I_{\Delta N} \geq 500$ mA (RCD type A)

Trip-out current

Trip-out current ($I_{\Delta N} = 10$ mA)

Measurement range corresponds to EN61557-6 requirements. Specified accuracies are valid for complete operating range.

Measuring range I_{Δ}	Resolution I_{Δ}	Accuracy
$0.2 \times I_{\Delta N} \div 1.1 \times I_{\Delta N}$ (AC type)	$0.05 \times I_{\Delta N}$	$\pm 0.1 \times I_{\Delta N}$
$0.2 \times I_{\Delta N} \div 2.2 \times I_{\Delta N}$ (A type)	$0.05 \times I_{\Delta N}$	$\pm 0.1 \times I_{\Delta N}$

Trip-out current ($I_{\Delta N} \geq 30$ mA)

Measurement range corresponds to EN61557-6 requirements. Specified accuracies are valid for complete operating range.

Measuring range I_{Δ}	Resolution I_{Δ}	Accuracy
$0.2 \times I_{\Delta N} \div 1.1 \times I_{\Delta N}$ (AC type)	$0.05 \times I_{\Delta N}$	$\pm 0.1 \times I_{\Delta N}$
$0.2 \times I_{\Delta N} \div 1.5 \times I_{\Delta N}$ (A type, $I_{\Delta N} \geq 30$ mA)	$0.05 \times I_{\Delta N}$	$\pm 0.1 \times I_{\Delta N}$

Trip-out time

Measuring range (ms)	Resolution (ms)	Accuracy
0 ÷ 300	1	±3 ms

Contact voltage

Measuring range (V)	Resolution (V)	Accuracy
0.0 ÷ 9.9	0.1	(-0 % / +15 %) of reading + 2 digits
10.0 ÷ 99.9	0.1	(-0 % / +15 %) of reading

B.4.4 Fault loop resistance and prospective fault current

Rs sub-function

Measuring range according to EN61557-3 is $0.32 \Omega \div 1999 \Omega$.

Measuring range (Ω)	Resolution (Ω)	Accuracy ^{*)}
0.00 $\div$ 19.99	0.01	$\pm(10 \% \text{ of reading} + 5 \text{ digits})$
20.0 $\div$ 99.9	0.1	
100 $\div$ 1999	1	

^{*)}The accuracy is valid if mains voltage is stable during the measurement.

Prospective fault current (calculated value)

Measuring range (A)	Resolution (A)	Accuracy
0.00 $\div$ 19.99	0.01	Consider accuracy of fault loop resistance measurement
20.0 $\div$ 99.9	0.1	
100 $\div$ 999	1	
1.00k $\div$ 9.99k	10	
10.0 $\div$ 24.4k	100	

IPFC calculation..... $I_{PFC} = U_N \times k_{SC} / Z_{L-PE}$

$U_N = 55 \text{ V}$, ($44 \text{ V} \leq U < 61 \text{ V}$) for selected 55 V single-phase system

$U_N = 63 \text{ V}$, ($56 \text{ V} \leq U < 70 \text{ V}$) for selected 63 V three-phase system

Test current 1.9 A (10 ms)

Nominal input voltage 55 V / 63 V (45 Hz $\div$ 65 Hz)

Test possibilities L1-PE and L2-PE

Rs(rcd) trip-lock sub-function

Measuring range according to EN61557 is $0.85 \Omega \div 1999 \Omega$.

Measuring range (Ω)	Resolution (Ω)	Accuracy ^{*)}
0.00 $\div$ 19.99	0.01	$\pm(10 \% \text{ of reading} + 15 \text{ digits})$
20.0 $\div$ 99.9	0.1	$\pm 10 \% \text{ of reading}$
100 $\div$ 1999	1	$\pm 10 \% \text{ of reading}$

^{*)} Accuracy may be impaired in case of heavy noise on mains voltage.

Prospective fault current (calculated value)

Measuring range (A)	Resolution (A)	Accuracy
0.00 $\div$ 19.99	0.01	Consider accuracy of fault loop resistance measurement
20.0 $\div$ 99.9	0.1	
100 $\div$ 999	1	
1.00k $\div$ 9.99k	10	
10.0 $\div$ 24.4k	100	

IPFC calculation..... $I_{PFC} = U_N \times k_{SC} / Z_{L-PE}$

$U_N = 55 \text{ V}$, ($44 \text{ V} \leq U < 61 \text{ V}$) for selected 55 V single-phase system

$U_N = 63 \text{ V}$, ($56 \text{ V} \leq U < 70 \text{ V}$) for selected 63 V three-phase system

Nominal input voltage 55 V / 63 V (45 Hz $\div$ 65 Hz)

Test possibilities L1-PE and L2-PE

No trip out of RCD.

B.4.5 Line resistance and prospective short-circuit current

Line resistance

Measuring range according to EN61557-3 is $0.25 \Omega \div 1999 \Omega$.

Measuring range (Ω)	Resolution (Ω)	Accuracy ^{*)}
0.00 ÷ 19.99	0.01	$\pm(5 \% \text{ of reading} + 5 \text{ digits})$
20.0 ÷ 99.9	0.1	
100 ÷ 1999	1	

^{*)}The accuracy is valid if mains voltage is stable during the measurement.

Prospective short-circuit current (calculated value)

Measuring range (A)	Resolution (A)	Accuracy
0.00 ÷ 19.99	0.01	Consider accuracy of line resistance measurement
20.0 ÷ 99.9	0.1	
100 ÷ 999	1	
1.00k ÷ 9.99k	10	
10.0 ÷ 24.4k	100	

IPFC calculation..... $I_{PSC} = U_N \times k_{SC} / Z_{L-N}$
 $U_N = 110 \text{ V}, (90 \text{ V} \leq U < 121 \text{ V})$
 Test current 3.1 A (10 ms)
 Nominal input voltage 110 V (45 Hz ÷ 65 Hz)
